Vulnerability and Adaptability: Modelling the Adaptive Capacity of Rural Households to Environmental Changes

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Dedication

To my parents, Mrs. Penina Atieno Mwamba and the late Mr. John Mwamba Odero, thank you for the stable foundation in my life.

Summary

This dissertation presents the results of an investigation of rural households' ability to adapt to changing environmental and climatic conditions. It presents soil degradation arising from worsening soil erosion, leaching, depletion of nutrients due to years of uninterrupted cultivation and low levels of use of fertilizers; uncontrolled deforestation leading to loss of biodiversity; and climate variability seen through longer dry seasons as well as delayed and falling levels of precipitation as key issues leading to the vulnerability of households in Kakemega District in Western Province of Kenya.

An enquiry has been made into the adaptation strategies of the rural households and a composite household adaptive capacity index (HACI) developed which is then used in hypothesis testing. Despite a situation laden with serious soil degradation and fears that credit taken by rural households often end up in low-return necessity-based enterprises or in consumption expenditure, the dissertation shows that the use of credit positively contributes to the HACI as does regular and optimal use of farm inputs. Diversification into non-agricultural activities, on-farm planting of trees and migration with remittances were some of the adaptation strategies observed among households with relatively high adaptive capacity indices while a secondary school level of education alongside the possession of non-land and non-livestock assets were key factors clearly associated with high adaptive capacity indices.

Regarding adaptation decision making, the household head was observed to be the single most important actor in a process which was often characterized by authoritarianism. The household head's level of information or awareness of environmental changes and open options proved to be important for adaptation. It was revealed that membership to groups and networks as well as government and NGO-activities were the most important factors in informing the household heads. Given small land sizes and a high incidence of other negative shocks, household heads tended to adopt and implement only tried and tested adaptation actions. During the study behind this dissertation, pioneers in the implementation of new strategies were observed to be better informed household heads or beneficiaries of incentives from the promoters of such strategies. Newer efforts aimed at the promotion of adaptability would therefore gain wider acceptance and adoption if preceded by a pilot phase carefully designed to include committed opinion shapers who would provide a demonstration effect.

Zusammenfassung

In dieser Dissertation wurden ländliche Haushalte bezüglich ihrer Anpassungsfähigkeit an den Umwelt- und Klimawandel untersucht. Desweiteren geht die Dissertation unter anderen der Frage über Strategien nach, die von ländlichen Haushalten angesichts der Auswirkungen von Umweltproblemen eingesetzt werden. Die Feldforschung wurde unter den Haushalten im Kakamega Distrikt in Kenia getätigt.

Eine Abnahme der Bodenproduktivität ist durch Erosion, einem Auslaugen und einer ununterbrochenen Kultivierung in Kakamega entstanden. Desweiteren führt eine unkontrollierte Abholzung mit resultierendem Verlust von heimischer Flora und Fauna sowie längeren Trockenperioden mit verspätetem Einsatz von Regenfällen und einer damit verbundenen Niederschlagsminimierung zu einer schwierigen Lebenssituation für die ländlichen Haushalte, die hauptsächlich durch Landwirtschaft ihre Existenz sichern. Diese Situation (gekennzeichnet durch Abholzung, Verlust der Artenvielfalt, Verminderung der Bodenqualität und unregelmäßige und wechselhafte Niederschlag) wird in dieser Arbeit als Umweltwandel (Environmental Change oder Environmental Stress) bezeichnet.

Es konnte unter anderem als eines der Ergebnisse der Arbeit festgestellt werden, dass die ländlichen Haushalte aufgrund schlechten Bodens, unkontrollierten Abholzungen, längeren Trockenzeiten und sinkenden Niederschlagsmengen sehr anfällig sind. Durch den Einsatz des zusammengesetzten Haushalt-Anpassungsfähigkeitsindex (Household Adaptive Capacity Index = HACI), der im Rahmen dieser Dissertation entwickelt wurde, konnten die Bedenken gemindert werden, dass Kredite, die an ärmeren ländlichen Haushalten vergeben werden, oft für Notgründungen und Konsumausgaben eingesetzt werden. Es hat sich herauskristallisiert, dass die optimale und regelmäßige Nutzung von Düngemitteln sowie der Einsatz von Krediten, die HACI positiv beeinflusst. Als weitere Ergebnisse konnte beobachtet werden, dass Haushalte mit höheren Anpassungsfähigkeitsindexen Anpassungstrategien wie Diversifizierung in nicht-agra Aktivitäten, Aufforstung und Migration verwenden, und, dass ein Sekundarschulabschluss und der Besitz von Wirtschaftsgütern mit hohen Haushalt-Anpassungsfähigkeitsindexen assoziiert sind.

Zum Anpassungsentscheidungspozess konnte festgestellt werden, dass Haushaltoberhäupter, die wichtigste Akteure sind. Entscheidungsweisen dieser Haushaltoberhäupten lassen oftmals

autoritäre Züge erkennen. So entscheiden die Haushaltoberhäupter häufig auch, in welcher Art und Weise Haushalte sich anpassen dürfen. Von daher ist das Wissen des Haushaltoberhauptes über die herrschenden Umweltbedingungen und die offenen Strategien oder Handlungspielräume von Bedeutung. Die Feldforschung zeigte, dass die Zugehörigkeit zu einzelnen Gruppen sowie die Bemühungen von der Regierung und den Nichtregierungsorganisationen wichtig für die Erhöhung des Wissens von Haushaltoberhäupten sind. Da der durchschnittliche Haushaltgrundstückbesitz sinkt und andere negative Ereignisse wie Krankheit und Tod zunehmend Angst verbreiten, setzen Haushaltsoberhäupter häufig nur dann empfohlene Strategien zur Anpassung ein, wenn sie beispielsweise einen Erfolg bei einem Nachbar verzeichnen können. Oftmals werden Anpassungsstrategien auch bei finanziellen Anreizen, zum Beispiel von Förderern, umgesetzt. Es würden mit hoher Wahrscheinlichkeit mehr Anpassungstrategien von ländlichen Haushalten umgesetzt werden, wenn diese Strategien Pilotprojekte beinhalten würden, die Haushalten das Zusammenspiel von Anpassung und Ernteertrag präsentieren.

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List of Abbreviations

Abbreviation	Full Phrase
BIOTA	Biodiversity Monitoring Transect Analysis (in Africa)
GHG	Green House Gas
GIGA	German Institute for Global and Area Studies
GoK	Government of Kenya
HIV/AIDS	Human Immunodefficiency Virus/Acquired Immune Defficiency Syndrome
IPCC	Intergovernmental Panel on Climate Change
KDHS	Kenya Demographic and Health Survey
KNBS	Kenya National Bureau of Statistics
MDGs	Millenium Development Goals
MFIs	Micro-finance institution
MSMEs	Micro, small and medium enterprises
RoK	Republic of Kenya
WMS	Welfare Monitoring Survey

1.0 Introduction: Structure and Objectives

This dissertation presents a study of the interrelationships and factors that affect the capacity of rural households to adapt to changing environmental and climatic conditions. Empirical evidence obtained from a field research exercise among rural communities in Kenya has been used in combination with contemporary knowledge to develop an index for household adaptive capacity which has, subsequently been used for hypothesis testing.

Contemporary literature has convincingly presented various accounts of the ongoing global warming as well as various decentralised cases of changing environments in various parts of the world with diverse effects, to/against which households have been motivated or forced to adapt/mitigate. The word 'adaptability' is herein used to describe the various levels of ability to adapt to prevalent or ongoing environmental and climatic changes. Adaptability is an abstract noun that stems from the adjective 'adaptable' which means 'capable of adapting or of being adapted'. The noun itself means the 'ability to change (or be changed) to fit changed or changing circumstances'. It connotes a potential which if actualised leads to a state of being adapted. The noun is therefore qualified to embody the degree to which adjustments are possible in practices, processes, or structures of households or systems to projected or actual changes in the prevalent environmental or climatic conditions. On the other hand, adaptation refers (in this context) to the process of adjustment in natural or human systems in response to actual or expected environmental and/or climatic stimuli or even the effects thereof, which helps to moderate harm or beneficially exploit emergent opportunities. Adaptation can be spontaneous or planned and can occur in response to or in anticipation of changes (IPCC, 1996). In most developing countries, the most common kind of adaptation seems to be the spontaneous and reactionary type rather than the anticipatory one.

Adaptability is often mentioned in connection with the existence of some sort of potential or actual change due to which a subject (for instance, a household) may need to adjust. The magnitude of the requisite adjustment is highly likely to depend on the extent to which the subject is or can be affected (negatively or positively) and its responsiveness to the effect (its level of vulnerability and sensitivity). Though environmental and climatic changes occasion both negative and positive effects in different parts of the world, this dissertation focuses on negative effects as these were observed to be the most critical and widespread in the area of study. The abstract noun – vulnerability – is used in this dissertation to refer to the extent to

which environmental changes (and the associated declines in natural resources) or climatic changes may harm a household. That is, the extent to which a household is at the mercy of the phenomena of reduction in natural resource supplies, especially due to environmental and climatic changes. A significant level of vulnerability stems from the households' exposure to the related phenomena of environmental and climatic changes (IPCC, *op cit*). Among other things, observations made by the author in Kakamega district of Kenya concurs with IPCC and suggests that household's/system's level of vulnerability depends on its sensitivity and its ability to adapt to the persistently changing conditions. Sensitivity as used here refers to the degree to which a system/household will respond to a change in the prevalent environmental, natural resource and/or climatic conditions, for instance - the extent of change in the ecosystem composition, structure and functioning or the extent of the subsequent change in household welfare (adapted from IPCC 1996).

In parts of this dissertation where the phrase 'climate change' has been used, the Intergovernmental Panel on Climate Change's (IPCC's) meaning of the phrase has been adopted: That is, 'climate change' refers to any change in climate over time, whether due to natural variability or as a result of human activity. Similarly, environmental change as used here refers to more localised changes in the surroundings of households arising out of both natural and human causes. On the other hand, 'environmental stress' has been used to refer to environmental changes of the negative kind. It refers to a situation of ecological damage resulting from interrelated factors such as deforestation, loss of biodiversity, soil degradation and unpredictability of rainfall over time. In this dissertation, relatively more focus is directed to environmental changes of this negative type because they were more prevalent in the area of study. As a result, more reference is made to environmental stress rather than the general term - environmental change. As will be illustrated in the following pages, households or systems are susceptible to climate change, environmental stress and the associated declines in natural resources through direct and indirect relationships. The level of susceptibility varies from system to system or household to household depending on various explanatory factors.

It will be shown in the later sections of this dissertation, that various kinds of environmental changes, declines in natural resource availability and the related phenomenon of climate change occasion diverse levels of vulnerability on the part of households. The households try to moderate the negative effects they face in their vulnerable situations by using various adaptation or mitigation strategies – either planned or spontaneous. The central role of

adaptability given environmental and climatic changes has been depicted in figure 1. For many a rural household, climate change is more of a 'given' whose impact is both direct as well as transmitted via the local weather and environmental/natural resource dynamics. It would take the co-ordinated and simultaneous actions by almost all households (not mentioning industry captains) at regional and global levels for any meaningful reduction of climate change to be felt by decentralised rural households such as those in Kakamega district of Kenya.

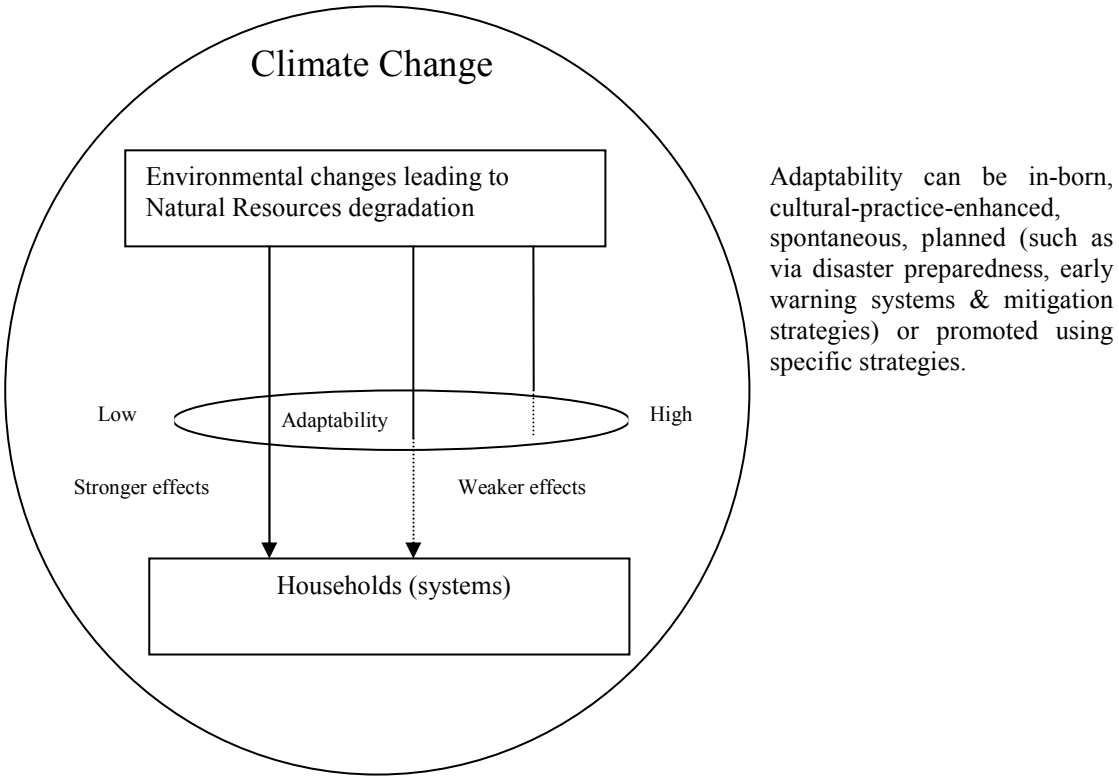
In figure 1, the higher/stronger the ability of households (systems) to adapt to environmental change (specifically environmental stress), diminishing natural resources and/or climate change, the weaker the negative effects of such changes on them (and the better placed they are to gain from any emergent beneficial effects). On the other hand, the lower/weaker the ability of households (systems) to adapt to environmental changes, the more damaging the negative effects of such changes will be on them and the less capable they are likely to be, to exploit any beneficial opportunities arising from such changes.

With specific reference to environmental stress, adaptability depends on the level of adaptive capacity inherent in or exhibited by a household such that an analogy can be drawn between the condition of an absorbent sponge and the state of adaptive capacity. When a dry hand-size absorbent sponge (has higher absorption capacity because it was initially dry) is exposed to a few millilitres of water on a flat surface, it will most probably soak up all the water. But if the absorbent sponge was initially at the brink of being soaking wet (lower absorption capacity), it may soak up very little if any water from the flat surface. In a similar fashion, if a household with a high adaptive capacity (analogous to a high absorption capacity) is exposed to a certain level of vulnerability, it may manage its vulnerable situation better than another one with a low adaptive capacity (analogous to a low absorption capacity). In other words, when it comes to negative effects of environmental or climatic changes, a high adaptive capacity is like an efficient shock absorber.

As it were, when adaptive capacity is drawn upon to set the adaptation process in motion, households can then (and only then) be said to exhibit a certain level of adaptability (that is, to be adaptable to a given extent or degree). Just like one can improve the absorption qualities of a sponge, household adaptability can also be enhanced in cases where they are low by using appropriate approaches and techniques. Different types of households often call for different

approaches depending on their individual characteristics and their adaptive capacities. However, in order to determine the adaptive capacity of a household at any point in time, there is need for an appropriate assessment tool capable of revealing any inter-household differences at any given point in time. Such a tool could help target the households with the lowest adaptive capacities with appropriately designed strategies to enhance their adaptability.

Figure 1: Households, Adaptability and Natural Resources given Climate Change



Source: Author's conceptualisation

Towards developing a household adaptive capacity assessment tool, the author designed and executed a field research exercise in Kakamega district of Kenya, the methodology for which is presented in chapter three and the output from which is presented in chapters four and five of this dissertation.

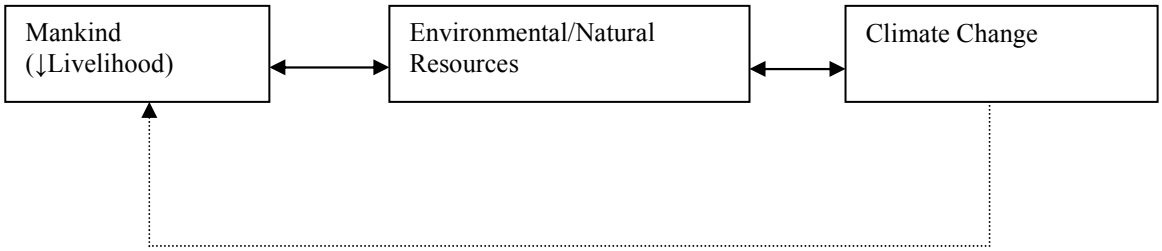
Chapter five also presents some of the strategies applied by the rural households in the face of environmental stress in the study area as well as the testing of research hypotheses. Factors associated with high adaptive capacities are also outlined. Chapter six is dedicated to concluding remarks, lessons as well as recommendations for policy and future research. However, before venturing into the specific issues of the field research, the following section presents the background issues followed by literature review in chapter two.

1.1 Background

The link between decentralised environmental conditions and global climate

The ongoing environmental changes in various decentralised regions of the world interact with the global climate in various patterns aided by certain anthropogenic factors. A relationship of mutual causation can be said to exist between these two phenomena in a fashion similar to that depicted in figure 2. In the figure, certain human activities (caused by both industrialists as well as rural farming groups) affect the state of environmental and natural resources with degradation being a common outcome and this outcome in turn aggravates climate change besides reducing the quantity and quality of available natural resource goods and services.

Figure 2: Mankind-Environment-Climate Nexus



(*Source: Author's conceptualisation*)

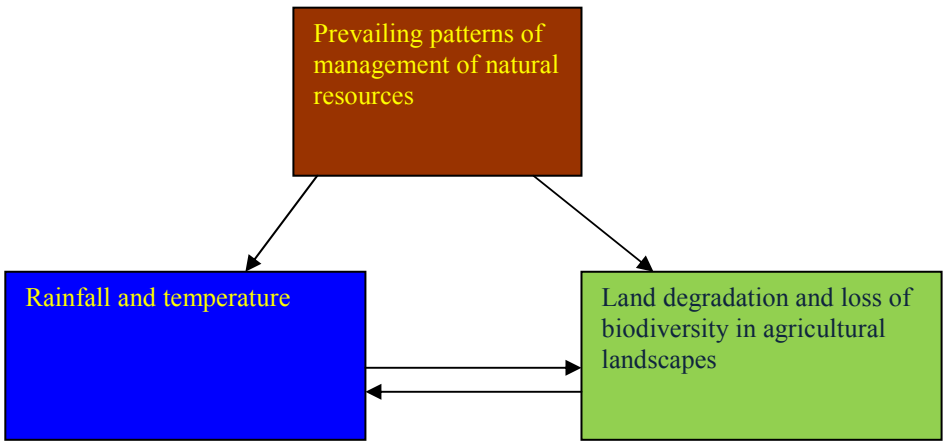
Figure 2 also shows climate change affecting environmental or natural resources (for instance, intensifying degradation processes). Climate change can, for instance, fuel the deterioration of the weather and environmental conditions while a deteriorated environment impacts livelihoods by, among other things, deepening low levels of living for mankind. Climate change also has direct negative[1] effects on mankind (especially the poor) by limiting the feasible economic activities in a number of geographical areas inhabited by people thereby perpetrating reduced livelihood opportunities (adapted from IPCC, 2007). In the available literature, climatic changes have been observed to have at least three main impacts on the rural poor and their livelihoods: Increasing environmental risks, reducing livelihoods opportunities and - in consequence - stressing existing social institutions (IPCC, 2007).

[1] Although reference is mostly made to negative effects of climatic and environmental changes, there are potential positive effects for some regions of the world. However, the area of study from where the data behind this dissertation was obtained featured predominantly negative effects associated with climatic and environmental changes hence the sharper focus on the same.

Among other things, climate change and the reduction in environmental resources caused by anthropogenic and other factors have had the combined effect of making many households (human beings) vulnerable. As such, households in some parts of the world, for instance – those in the developing world, have had to rely on their ability to adapt to life under the conditions of declining availability of natural resource commodities and a continuously changing climate. The fact that the practices and livelihood patterns of rural households often impact negatively on their immediate natural environment and the regional/global climatic patterns cannot be gainsaid. However, as previously mentioned in relation to figure 1, the global climate change phenomenon is to a large extent, a 'given' for most decentralised rural households in developing countries because the impact of any of their efforts to adopt low emission production techniques or practices so as to reduce their negative effects on (and therefore their vulnerability to) climate change would only lead to marginal gains unless the industrialists and other households in other regions co-operate.

To help locate the central role of anthropogenic factors in the environmental and climatic dynamics, figure 3 illustrates the interrelationship between patterns of management of natural resources and land degradation & loss of biodiversity in agricultural landscapes as well as their links to prevalent rainfall and temperature levels. Where there is poor natural resource management such as poor land use patterns or excessive deforestation, important biodiversity is lost in agricultural landscapes thereby affecting the weather (for instance by perpetrating drought). The latter is often accompanied by reductions in livelihood options.

Figure 3: Natural Resource Management Patterns, Environment and Weather/Climatic Elements



(*Source: Adapted from BIOTA Africa*)

This is partially due to the fact that once land degradation and loss of biodiversity sets in due to poor natural resource management patterns, changed weather patterns are highly likely to set in and disrupt agriculture as a source of livelihoods. For most rural households, disruptions in agriculture often lead to significant losses of income and reduced levels of living or even absolute poverty. Poverty (low levels of living) has been linked to a low capacity to adapt to environmental stress and climatic changes (Kelly & Adger 2000). Moreover, poor people often live in risk-filled environments and subsist on natural resources that are negatively affected by environmental stress and climate changes (Kates & Haarmann 1992, Blaikie *et al*, 1994). Disproportionately affected by such changes have been the (rural) poor in developing and least developed regions of the world.

The Kakamega District of Kenya where a household survey was carried out to supply empirical observations for this dissertation presented a situation in which human population pressure has led to serious land scarcity and the poverty of the rural households aided by poor land management practices has perpetrated increased levels of land degradation. Poor land use systems and the high pressure exerted on Kakamega Forest[2] by surrounding households has increasingly perpetrated the loss of biodiversity and further fuelled land degradation. Deforestation and unsustainable extraction of forest products has promoted soil erosion and this situation combines with irregular rainfall patterns and gradually precipitates water stress in the district. Drought conditions resulting from weather changes add to the aforementioned factors to put many of the rural households of Kakamega in a precarious condition.

1.2 Problem Statement

With the above explained background, there has been an apparent need to assess the extent to which rural households possess an adaptive capacity in the face of the prevailing natural resource dynamics, environmental changes and climate variability. As is explained in the other sections of this dissertation, the adaptability of households depends on their levels of adaptive capacities which need to be appropriately assessed to facilitate better understanding and the information of policy making processes. An appropriate assessment tool fitting such rural areas like Kakamega district of Kenya has however been lacking.

[2] A formerly biodiversity rich tropical forest remnant located in the western province of Kenya.

Some factors which appear to influence adaptive capacity have also tended to deliver less clear-cut results for different rural households. Use of credit for investment activities and use of farm inputs are such factors. In the largely agricultural region of Western Kenya for instance, farming has remained rain-fed and land degradation has made the use of fertilizer critical to the success of farming yet household finances are often inadequate for farm input needs. This situation often creates a need for credit to complement household savings when purchasing farm inputs like fertilizer. However, previous research experience in the area by the author (in 2006) revealed that farmers were increasingly asking themselves the question: Why take credit to invest in farm inputs when the increasing unpredictability of rainfall raises the chances of crop failure thereby raising the likelihood of defaulting in credit repayment? Among other things, default meant loss of assets used as collateral security, loss of trust and a wounded reputation. Issues related to defaulting on microcredit repayment have also raised uncertainty among several rural households in other parts of the world like India. In Kenya's Kakamega district, erratic rainfall patterns and land degradation has tended to bring credit-taking for farm input purchases and the actual use of farm inputs much closer to high-risk gambling activities (at least in perception). Can the use of credit and farm inputs still be counted on as useful components of adaptation strategies in face of environmental and climatic changes? There has been need for research and reassurance of the increasingly uncertain rural households.

This dissertation therefore made serious efforts to develop an index for the adaptive capacity of rural households and improve understanding on the issues like use of credit, farm inputs and diversification as they affect adaptability.

1.3 Theoretical and Methodological Contribution

Declines in quality and quantity of natural resources and the related phenomenon of climate change have a direct impact not only on economic growth but also on efforts to reduce poverty. The achievement of human development targets such as those outlined in many of the Millennium Development Goals (MDGs) partially depends on the ability of human beings to adapt to and, where necessary, mitigate against environmental and climatic changes because: Whereas climate change has already been reported to be increasing the frequency and intensity of severe weather events, diminished supply of natural resources in stressed environments is directly weakening the sources of livelihoods of numerous households (IPCC 2007). The IPCC (2007) further notes that diseases such as malaria are likely to have

increasingly wider ranges impacting even more people in the poorest regions of developing nations already most affected by such diseases. Changing rainfall patterns has in a number of areas devastated rain-fed agriculture (especially in rural areas) on which so many people in developing countries depend for survival. Whereas some households facing environmental problems have significant resilience, numerous others have very little resilience if any.

This dissertation contributes a better tool (HACI) for use in the assessment of the ability of individual households in rural regions of the world to adapt to changing environmental conditions. Proper assessment will then pave way for to the design and execution of appropriate policy interventions which seem urgently necessary to secure the currently threatened livelihoods of many rural households. Whereas research appeared to be inconclusive on the important factors positively associated with high adaptive capacity, this dissertation submits that optimal farm input use and diversification into non-farm economic activities are key to enhanced adaptability with finance (for instance in the form of micro credit) being a necessary though insufficient condition towards higher household adaptive capacities. To the extent that the household adaptive capacity index (HACI) facilitates the proper targeting of the most pressing cases of households with the appropriate set of strategies aimed at raising adaptability, it has the potential of saving lives. The methods available for assessing adaptability, especially with regards to rural households, have, for long, remained sub-optimal for use in geographical areas other than those for which they were developed.

1.4 Objectives

The research carried out for this dissertation had the following key objectives:

- To advance understanding of the vulnerability and adaptive capacity of rural households to environmental change (particularly environmental stress) and climate variability;
- To develop a robust household adaptive capacity index (HACI);
- To find out the key stages in the adaptation decision making process;
- To elucidate the adaptation efforts exhibited by rural households in response to changes (declines) in the supply of environmental and natural resource goods and climatic changes; and
- To point out strategies and factors associated with higher household adaptive capacities.

1.5 Research Questions

The research questions at the core of this dissertation are:

1. What are the key factors influencing adaptability of rural households to environmental change (stress) and declines in natural resource goods?
2. What is the process of adaptation decision making among the rural households?
3. What are the conditions that stimulate or constrain adaptation among the rural households?
4. Which are the adaptation strategies being employed by rural households to adapt to environmental stress and what are the key outcomes of such strategies since being employed?

So far, experience from various regions of the world suggest that rural households can, to a limited extent, adapt and indeed are adapting to changes brought about by the declines in natural resources and environmental changes (even though the rate at which they are autonomously adapting is much slower than the incidence of the negative effects of climatic and environmental changes together with the associated resource declines).

1.6 Hypotheses

With a significant number of households in the area reporting[3] that there was increased uncertainty as to whether households would recoup their investments in farm inputs, the study sought to establish whether positive returns (inform of improved household economic situation) accrue to households using inputs like inorganic fertilizer on their degraded soils. Since household levels of living are closely related to their adaptive capacities, the hypothesis adopted was:

H1: Regular and optimal farm input use positively influences the HACI

A second hypothesis arose from an observation of a rising fear of credit among area residents with many poor households claiming that credit often deepened their poverty since the high prevalence of negative shocks often made them to default thereby ending up losing the collateral security (assets) or sinking deeper in debt. Critics of microfinance such as Dichter

[3] During a field research (by the author) consisting of participant observation in 2007 in the area of study, interactions with some households revealed a rising tendency of demotivation regarding the purchase and use of farm inputs since erratic rainfall raised the potential for losses thereby making an increasing number of households perceive farm inputs as an increasingly risky investment.

(2007) have also labelled it as a low return philanthropic movement. The critics point out that a big number of the beneficiaries spend the borrowed money on necessity based enterprises with low success chances and on consumption expenditure given their poverty situation. Should it be the case that credit (microfinance) leads poor households to more debt and deepened poverty levels, then it is also likely to be associated with a low household adaptive capacity index. If the reverse holds true in the area of study, then credit would also positively influence the household adaptive capacity index, at least in the same area. The study therefore tested the hypothesis:

H2: Credit positively influences the HACI

The research behind this dissertation also closely examined diversification of income as it relates to adaptation. A previous study (Michuki, 2007) in the area of study showed households diversifying into non-farm activities to enhance their livelihoods. Authors like Minot *et al* (2006) also emphasise a positive role of diversification into non-farm activities on income and poverty reduction at the family level. A closer look was therefore accorded to the overall impact of diversification on the household adaptive capacity index.

1.7 Scope and Limitation of the Study

The Intergovernmental Panel on Climate Change's (IPCC, 2007) emphasis on climate change as a development issue is one of the many revelations of the fundamental shifts in the approach of many persons as concerns the dynamics of the environment and global climate. Whereas the exposure and sensitivity elements have a history of research, the history of research on adaptive capacity is relatively short. In an effort to carry the research on adaptive capacity forward, this dissertation focused on rural households in Kakamega district of Kenya so as to gain a deep insight into their adaptability. Kakamega district is a medium potential agricultural area and therefore, application of the results of this study in other settings may necessitate some level of adjustment (for instance, using modified weights) to suit prevalent conditions, for instance, in arid areas.

The contribution of this dissertation will be useful to academicians, individual households, government agencies and non-governmental organisations to the extent that they shall be able to apply the output from this dissertation in similar settings or adapt it to other settings. The

HACI enables policy makers and relevant stakeholders to more appropriately target vulnerable households and regions in future. International actors such as the United Nations Framework Convention on Climate Change (UNFCCC) have directed increasing focus on climate change policy process relating to the potential for adaptation and national level assessments of adaptive capacities have been favoured. This creates more potential for the use of the HACI since micro-level surveys feed into the national level ones which then inform central government policy and assist the allocation of resources to support the aims of governments as well as those of the UNFCCC.

Besides facilitating comparison, the proper identification of households or regions with low adaptability can facilitate better understanding and addressing of the processes that cause and exacerbate vulnerability. Furthermore, as Reid & Vogel (2006) also observed, attention to vulnerability shaped by multiple causes that aggravate and which may enhance impacts of climate stress, is becoming an important research arena requiring more data informed from local studies, particularly in those countries where climate change may limit development activities (Pielke, 1998; Huq & Reid, 2004; UNDP, 2004). There exists immense potential for use of the findings in this dissertation to inform local studies in future.

Due to time and resource constraints, external factors influencing the household adaptive capacity index (such as the role of the government and macroeconomic issues) could not be researched exhaustively.

1.8 Structure of the Dissertation

The introductory chapter has provided explanations, definitions, relationships, background, problem statement, hypotheses and study limitations so as to familiarise the reader with the issues at hand while the second chapter (on literature review) documents the contemporary debate on the environmental and climatic issues, vulnerability as well as adaptation. Chapter three presents the methodology used in solving the problem stated in the introductory chapter with chapter four presenting the development of the HACI from field research data. In chapter five, the developed HACI has been used to test hypotheses and isolate the factors associated with high adaptive capacities. The concluding chapter summarises the lessons arising from this research and makes recommendations for policy as well as some for future research.

2.0 Environmental and Climate Change

Vulnerability to changing environmental and climatic conditions (which lead to declining supplies of natural resource goods and services) is a phenomenon that has been causing increasing levels of concern in many regions of the world. Various forms of responses including the enhancement of adaptability have also been put forward. This chapter is dedicated to the review of information touching on vulnerability and adaptability. From climate change through to the related phenomenon of declining natural/environmental resource supplies and the vulnerability posed thereof, the following section supplies insight before giving way to a focus on adaptive capacity.

2.1 Climate Change

In 2008, Ahmed Djoglaf – the executive secretary of the Convention on Biological Diversity observed that climate change and biodiversity losses are two real and related challenges of our time. According to the IPCC (2007), the concentration of carbon dioxide (CO_2) in the Earth's atmosphere had reached a level not seen for some 650, 000 years and the cause was linked to human activities. On the other hand, the Secretariat to the Convention on Biological Diversity (CBD, 2006) predicted that before the end of the century, species and ecosystems will struggle to keep pace with changes in temperature and rainfall and extinction rates will increase. The CBD added that "the consequences of climate change will be distributed unequally around the globe, but will affect the most, vulnerable countries. Africa, which contributes the least to climate change, will be the first to suffer. As an example, climate change has already greatly contributed to the reduction in the levels of Lake Victoria leading to a drop by about 30 per cent. Furthermore, between 25 and 40 per cent of Africa's unique species could be lost by 2085!"

Recent climatic changes and climate variations are beginning to have effects on many other natural and human systems (IPCC, *op cit*). However, based on the published literature, the impacts have not yet become established trends (IPCC, *op cit*). IPCC gave the following examples:

• Settlements in mountain regions are at enhanced risk of glacier lake outburst floods caused by melting glaciers. Governmental institutions in some places have begun to respond by building dams and drainage works.

• In the Sahelian region of Africa, warmer and drier conditions have led to a reduced length of growing season with detrimental effects on crops. In Southern Africa, longer dry seasons and more uncertain rainfall are prompting adaptation measures.
• Sea-level rise and human development are together contributing to losses of coastal wetlands and mangroves thereby increasing damage from coastal flooding in many areas.

The IPCC (2007) made some projections in view of the ongoing global climatic changes. The following is a selection of some of the key projected impacts, as well as some findings on vulnerability and adaptation, in each system, sector and region for the range of (unmitigated) climate changes projected by the IPCC over this century and judged to be relevant for people and the environment.

Fresh Water Systems: By mid-century, annual average river runoff and water availability are projected to increase by 10-40 per cent at high latitudes and in some wet tropical areas, and decrease by 10-30 per cent over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water-stressed areas. The number of people living in severely stressed river basins is projected to increase significantly from 1.4 - 1.6 billion in 1995 to 4.3 - 6.9 billion in 2050.

Ecosystems: The resilience of many ecosystems (their ability to adapt naturally) is likely to be exceeded by 2100 by an unprecedented combination of change in climate, associated disturbances (for example, flooding, drought, wildfires, insects and ocean acidification) and other global change drivers (for example, land-use change, pollution and over-exploitation of resources).

Food fibre and forest products: Crop productivity is projected to increase slightly at mid to high latitudes for local mean temperature increases of up to 1 - 3°C depending on the crop, and then decrease beyond that in some regions. At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1 - 2°C), which would increase the risk of hunger.

Coastal Systems and Low Lying Areas: Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise. Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s. Those

densely-populated and low-lying areas where adaptive capacity is relatively low, and which already face other challenges such as tropical storms or local coastal subsidence, are especially at risk. The numbers affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable.

Health: Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through increases in malnutrition and consequent disorders, with implications for child growth and development among other things. Climate change is expected to have some mixed effects, such as a decrease or increase in the range and transmission potential of malaria in Africa. Critically important will be factors that directly shape the health of populations such as education, health care, public health initiatives and infrastructure and economic development (IPCC, 2007).

The above projections put forward by the IPCC are bound to be discomforting to many rationally thinking persons and one would hope that all persons would urgently institute serious emission reduction as well as mitigation and adaptation programmes. Unfortunately, as at 2010, international efforts to confront the climate change phenomenon was hindered by short-term fears and interests. The classical problem facing effective conservation of common goods has neither spared the global climate nor has it had mercy for localised environmental and natural resources!

2.2 Environmental Changes

As illustrated in the introductory chapter, there is a link between the status of the environment and the prevalent climatic conditions. The IPCC (2007) notes that, climate change vulnerabilities of industry, settlement and society are mainly due to extreme weather events rather than to gradual climate change, although gradual changes can be associated with thresholds beyond which impacts become significant. It further adds that climate change impacts spread from directly impacted areas and sectors to other areas and sectors through extensive and complex linkages. Related to this, Kelly & Adger (2000) espouse that it is short term hazards and extreme climate events on the seasonal and inter-annual time scale that the bulk of any population experiences and reacts to, rather than long term trends, and it is through the varying character of these events (say local environmental stress, droughts, floods

and climate variability) that any long-term change in climate will first be manifest. Environmental changes therefore partially result from climate change and the former are also contributes to the latter phenomenon.

Just as climate change increases the number of people at risk of hunger marginally - with respect to overall large reductions due to socio-economic developments (IPCC, 2007), environmental stress (changes of the negative type) does exactly the same by hindering food production at the local and regional levels. Observations made by the author in Western Kenya shows that households are more likely to notice negative environmental changes and their impacts faster than they would positive ones. This is because most negative environmental changes often directly affect their livelihoods. The high population growth prevailing in many tropical regions like Western Kenya exerts a lot of pressure on the environment leading to a situation where negative environmental changes have become more pronounced and widespread thereby completely masking any positive environmental changes. Over time, intensification of negative environmental changes in some regions has exceeded the resilience of ecosystems leading to environmental stress. Among the pastoralist communities of Kenya, for instance, the increased frequency and severity of droughts in the recent past indicate that overstocking has exceeded the carrying capacity of the environment (ecosystem). Elsewhere, excessive deforestation in some farming regions has raised average temperatures and this drives climate variability thereby affecting yields from farming. The deforested regions become more exposed to soil erosion and degradation besides being biodiversity-poorer.

According to Ogunlade *et al* (2003), in parts of Africa, tree clearing for agricultural reasons which is the primary cause of deforestation and soil erosion, has become an essential act to meet the food needs of rapidly growing populations. The authors add that previous methods – leaving land fallow for long periods and maintaining the balance between human activity and natural vegetation – have been shattered and fallow periods are steadily diminishing, thwarting the proper regeneration of agro-ecosystems. In rural Africa, low energy (electricity) consumption is both a cause and a consequence of poor development and also of degradation of the natural environment (such as through deforestation) while uncontrolled use of biomass continues to aggravate soil erosion and flooding; and retards development actions (Ogunlade *et al*, 2003). Given the pronounced nature of negative environmental changes in many tropical regions (lower latitudes) especially in Sub-Saharan Africa, it is more appropriate to refer to

(and address) environmental stress which manifests itself in degraded (eroded, overworked, leached or barren) soils, flooding in some areas, loss of biodiversity (including desertification) and climate variability (unpredictable or erratic rainfall and prolonged dry periods). Such decentralised changes feed into (and are also worsened by) regional and global climatic changes.

Even though environmental stress, climate change, loss of biodiversity and desertification are frequently addressed separately at the international level, to an impoverished farmer, the degradation of several natural resources that together form his or her subsistence base is considered a single problem and therefore should be tackled holistically at the local level (Eriksen, 2001). For many rural residents in Kakamega District of Kenya for example, soil degradation, decline in the number and diversity of the plant and animal species, climate risks, floods, changed/erratic weather, reduced precipitation and droughts comprise the set of tribulations visible to them[4]. Political upheavals, diseases such as HIV/AIDS, malaria, tuberculosis and insecure land access further compound the local challenges faced by the rural households.

Since this dissertation is based on a field research exercise in a rural setting in Kenya, it is important to, at this stage, elucidate the local environmental issues and how they fit into the general climate-environment nexus.

Dynamics in Natural or Environmental Resources in Kenya

At the national level in Kenya, climate change and environmental degradation concerns soar when one looks at the serious disturbance occasioned to water catchment-areas which has rendered rainfall erratic and contributed to the silting up of the water dams (when it eventually rains). Among other associated challenges, the resulting soil erosion problem has made the maintenance of reservoirs and turbines expensive and reduced their efficiency in Hydro-Electric Power (HEP) supply process. The country largely depends on HEP and it has five key water towers of which the Mau water tower is the biggest followed by the Aberdare water tower. Others are the Mt. Kenya, Mt. Elgon and the Cherenganyi Hills water towers.

[4] This is according to the observations made by the author during a research exercise carried out by the author in the area in 2006.

The destruction of water catchment areas by people who have encroached on key resources in the water towers such as the Mau forest and careless felling of trees continue to pose tremendous challenges to Kenya thereby compounding the challenges of erratic weather patterns, delayed onset of the rainy seasons and reduced precipitation in the country. As a result, both rural and urban households suffer from water scarcity which has often meant large scale crop failure/livestock depletion, hunger, deaths, power cuts, water rationing and raised commodity prices. The period 2008 – 2009 will for instance be remembered by the residents of Nairobi and surrounding areas due to the low water levels in Sasamuwa dam which resulted from low water flowing from the Nyandarua ranges (within the Aberdare water tower) from where the Athi, Tana, Ewaso Nyiro and Malewa rivers draw their waters.

The United Nations Environment Programme (UNEP) recently identified illegal settlements, logging, illegal cultivation, charcoal burning, quarrying and livestock grazing as some of the key threats to Kenya's water catchment areas. In an attempt to stem the Aberdare forest degradation, the Kenya Wildlife Service has almost completed fencing the resource. In the Mau forest (Mau water tower), politically well connected individuals had (legally and illegally) acquired forest land and also settled some communities into the forest land, actions that resulted into tremendous degradation of the water tower due to unregulated logging and cultivation. This happened under a regime[5] and in an era where political patronage and sycophancy rendered the rule of law irrelevant. Under that regime, loyalty was rewarded with public land or positions for friends and relatives in the civil service (this rendered civil service unprofessional) while poorer sections of the electorate were allowed to cultivate crops inside public land so as to win their support during elections but this led to forest destruction. The recent efforts to remove the forest settlers and reforest the Mau water tower have been so heavily politicised in Kenya's ethnically polarised society that the progress has been painfully slow.

Following years of forest destruction, Kenya has only about 3 per cent of its land under forest compared to the desirable 10 percent (see annex 2 for more information on management of forests in Kenya). Partly due to the local environmental destruction and global climate change, the intensity and scope of the drought phenomenon in Kenya has markedly increased

[5] The Kenya African National Union (KANU) party remained in power from independence 1963 – 2002 with the 2nd president perfecting patronage in his 24 year rule. Under the 1st president, seeds of patronage and impunity had been sown. Public resources were mismanaged since the word of the powerful politicians was perceived to be 'greater than the law' with the phrase 'orders from above' finding frequent usage.

over the last two decades with alarming increases in hunger/drought related deaths of livestock and human beings in areas like Makueni, Isiolo, Kajiado, Narok, Laikipia, Turkana, Kwale and Tana River districts. Some of the key incidences of drought in Kenya in the recent past are presented in table 1. Human-wildlife conflicts also intensified in areas inhabited by pastoralist communities such as the Maasai and Samburu. Baboons joined lions and leopards in attacking and feeding on pastoralists' livestock. In the period 2005 - 2011, for instance, increasing cases of baboons eating goats belonging to pastoralists in areas like Kajiado North were reported while in Lake Bogoria, baboons were observed to be frequently attacking and eating flamingos. With the Kenyan government being slow to compensate the pastoralist communities for losses occasioned by wild animals (wildlife is an important pillar in Kenya's tourism industry), the latter have displayed increased intolerance against the wildlife with whom they have historically shared ecosystems, thereby further threatening a natural resource already under attack from poachers.

Table 1: Recent Intensification of Adverse Weather in Kenya

Hard hit Region or Area	Period when biting drought caught national attention	Casualties	Remarks
North Eastern province, Northern part of Rift Valley province, parts of Eastern province (i.e. Isiolo) and Coast province	December 2010 – Jan 2011: Ijara, Samburu, Tana River, Mandera, Wajir, Turkana, Pokot, Isiolo, Makueni, Kitui, Kajiado, Machakos	*La Nina* frequency quickens : 5 deaths of people and losses of livestock leads govt to allocate KES 5bn to mitigation kitty in January 2011	Kenya's meteorological department predicted drought from Dec. 2010 to mid 2011 related to the *La Nina* phenomenon
Kajiado (North) - residents report area's worst drought in over 20 years.	2008/2009	Loss of livestock, baboons eating goats. Three killed as Samburu and Turkana clash over water	10 million people faced starvation. Herders clash with youth in Ruiru peri-urban area over pastureland. Govt declares drought a national disaster appeals for aid on 16.01.2009.
Baringo	2008/2009		Residents survive on wild fruits
Areas like Laikipia, Kwanza and Kieni join Nyakach, Rachuonyo (Kano plains), Budalangi and Tana River in experiencing flooding	May 2010	Wider spread of water-and vector-borne diseases	New flooding areas registered

Source: Author's Compilation

The worsening climate variability and environmental stress is highly likely to continue to make certain agricultural crops yield poorly in some areas and sea level rise is likely to threaten an increasing number of coastal communities. There are also worsening impacts of perennial floods in western, coastal and other parts of the country as deforestation leads to

ever increasing speed of surface run-off thereby burdening low-lying areas. Highland malaria has in the recent past, (and is likely to continue to) spread to new areas. Meanwhile, rapid population growth continues to push people into areas like wetlands and highlands which were previously unattractive to human settlement. These developments threaten rural households in Kenya with a myriad challenges to which they must adapt or institute mitigating strategies in order to survive.

Just like in other regions of the world, the survival of Kenyan rural households continues to be intricately intertwined with the health of their surrounding ecosystems. Unfortunately, delicate ecosystems are being destroyed by human activities thereby further worsening the plight of both rural and urban residents. Increased population growth and years of unsustainable cultivation as well as pastoralist activities have stretched the carrying capacities in many ecosystems in Kenya beyond their optimal rejuvenation thresholds. The aforementioned cases of baboons attacking and eating pastoralists' goats and flamingos in stressed ecosystems in parts of Kenya are likely to be signs of overwhelmed systems. Many local ecologists are seriously concerned over the resilience of ecosystems (ability of an ecosystem to overcome or survive external shocks) in several parts of the country.

Holling, 1973 asserts that the magnitude of stress which a system can withstand and the time to recovery are important as is the vigour – primary productivity of an ecosystem. The prevailing natural resource degradation, pollution and biodiversity loss are therefore detrimental because they increase vulnerability, undermine system health and reduce resilience (ability to recover from impacts - Perrings & Opschoor, 1994). Due consideration for the safe threshold and the carrying capacity of ecosystems is imperative to avoid ecosystem collapse. As it were, system resilience will depend dynamically on the capital endowment as well as the magnitudes and rates of change of shocks. In Kenya as in numerous other areas, overexploitation of environmental and natural resources by human beings has combined with global warming to pose threats to ecosystems and hence to future development activities and wellbeing of large numbers of human beings.

In a recent field research (Mwamba, 2007), it was revealed that many rural households in Kakamega district (most of them poor) are challenged by highly degraded (barren and eroded) soils as well as reduced incomes due to stricter control of the use of the Kakamega forest[6] on

[6] Kakamega forest consists of a main forest block surrounded by several fragments with distinct names.

which the surrounding households have historically heavily relied. Farming (of crops like maize, coffee, sugarcane, bananas, beans and horticulture) has been the mainstay of the Kakamega District economy with over 90 per cent of the population living in the rural areas depending directly or indirectly on agriculture. By 2007, it was estimated that 75 percent of the population worked in the agricultural sector with livestock (cattle, sheep, goats and poultry) contributing significantly to socio-economic wellbeing through sale and consumption of livestock products such as meat, hides, skins and milk (GoK, 2002).

At the time of this dissertation, the forest was being managed by three management regimes (the forest department – FD, the Quakers and the Kenya Wildlife Service – KWS) each carrying out its function in a different manner. Extraction of direct forest products was the main incentive offered by two of the regimes and the local community continued to directly depend on the forest for items such as fuel-wood, charcoal, building materials, fruits, mushrooms, traditional medicinal plants, game meat, grazing land and timber. The size of the forest has been shrinking rapidly due to human population pressure and increased resource extraction in the last century. In the last three decades, approximately 20 per cent of the forest has been lost (Lung & Schaab, 2004) and this development saw the government tighten restrictions on the access to the forest's resources. For instance, in 2004, the Kenya government enforced a complete ban on non-resident cultivation in all indigenous forests and cattle-grazing within the Kakamega forest was tied to grazing fees. On the part of the Kakamega forest under its jurisdiction (which is also a national reserve), the KWS very strictly prohibits forest extraction.

From interactions with the interviewees during field research, most household heads were nostalgic of days prior to the stricter controls, when they could freely obtain timber from the forest and some strongly lamented over the withdrawal of non-resident cultivation which previously earned them a lot of money (sometimes more than half their annual incomes) from the sale of crops harvested. Some interviewees longed for the return of the days when they could graze their cattle freely in the forest land.

During the previous survey carried out by the author in 2007 using participant observation of 100 households, 98 per cent reported that firewood was the main resource for which they relied on the environment (setting land aside) and that the same had been the case for their parent households. For 95.1 per cent of the (mostly rural) households, wood was the main

source of fuel although some supplemented this with charcoal, kerosene, electricity, solar and cooking gas (Mwamba, 2007). It was evident that the previous generations had had better access to natural resource goods. Stricter government control of forest resources (see annex 2 for more information) was reported as the main factor that had greatly reduced the households' access to environmental/natural resource goods with 92.2 per cent reporting loss of incomes of up to KES 5500 per annum[7]. This had forced at least a restructuring in the budgets of many of the households while for some; it had meant that their household incomes were substantially reduced. Those bordering the forest (especially in Ileho division) had had the largest reduction in incomes (in some cases by up to 50 per cent) ever since the tightening of restrictions on the use of Kakamega forest.

It was also observed that the trees planted by individual households had been inadequate in satisfying their demand leading to the stealing of forest trees. The number of trees and other vegetation growing on private land had also seriously diminished exposing the land in the area to soil erosion while regular cultivation of the land with little if any fertilizer/manure meant that the soils could not regain nutrients after each harvest; hence severely degraded, eroded and drier soils. The overall situation in Kakamega District could be summarised as one of decreased access to forest products, overexploitation of vegetation/trees, degraded soils in the small plots and erratic weather which all appeared to compound households' vulnerability to the resultant environmental changes (stress). Indeed, GoK (2005b) identified environmental degradation, deforestation, soil erosion and pollution as main problems in Kakamega district, which were being driven by a high population growth rate.

2.3 Vulnerability

As earlier explained, vulnerability has been used in this dissertation to refer to the negative exposure of households to the related phenomena of environmental stress and climate change. This definition facilitates a better focus and distinguishes the meaning of the word as here used from others attached to it by other authors. An analysis of vulnerability also involves identification of concepts of 'risk', 'threat' and 'resilience' (Mohanty, 2007). According to

[7] It is worth noting that the marginal utility per Kenya Shilling (KES) is – relatively speaking - very high for the very poor. Forest Department & Quakers allowed grazing in the forest at a fee: KES 1050 per month per animal (35 per day/animal). Total value of grazing per year per household was KES 42,108 (US$ 569.03). A gunny bag of charcoal had a market value of about KES 300 (US$ 4) in the area of study. Estimated at KES 14400 (US$ 192) per year per household. A head lot of firewood went at KES 50 (US$ 0.68) and average value of harvested wood by extracting households was KES 6274.18 (US$ 84.78) p.a. per household (Guthiga & Mburu, 2006).

Kasperson (2001), communities or households that are most vulnerable may also be those most at risk. Kasperson (*op cit*) places vulnerability in the context of a long continuum ranging from resistance and resilience to susceptibility. Households may however be facing the same risk but not equally vulnerable. On their, part for instance, after noting that traditional notions of vulnerability have tended to hold global trends constant thereby missing some of the key driving forces that alter vulnerability patterns, Leichenko & O'Brien (2002) use the phrase 'dynamic vulnerability' which they define as the extent to which environmental and economic changes influence the capacity of regions, sectors, ecosystems and social groups to respond to various types of natural and socio-economic shocks. Prior to Leichenko & O'Brien's publication, Ramachandran & Eastman (1997) made reference to the concept of dynamic vulnerability (see annex 3b).

The two authors - Leichenko & O'Brien (2002) – propose that vulnerability must be considered from a comprehensive perspective since it is being influenced by larger-scale economic and environmental changes. They add that farmers, for instance, have to adapt to both climatic change and economic changes simultaneously and these changes may make certain groups which were not previously vulnerable to be so, whereas traditionally vulnerable groups may become more (or less) vulnerable. The two authors state that seasonal climate/weather forecasts – boost adaptation but there is need for access to credit, equipments such as tractors and inputs to complement these forecasts in enhancing adaptability. They add that due to globalisation, farmers who formerly had difficulty adapting to climate variability may become less vulnerable to drought-related food shortages as a result of trade liberalisation.

This dissertation acknowledges the significance of the authors' concept of vulnerability and examines the effect of the use of farm inputs and access to credit on household adaptive capacity through the testing of two hypotheses related to these issues. Whereas Leichenko & O'Brien suggest that credit and farm inputs enhance adaptation, a significant number of farming households in some developing areas such as Kakamega district have been observed to display a marked fear of credit while others tend to have become pessimistic when considering the use of farm inputs in the face of erratic rainfall patterns. Previous research in Kakamega revealed that delayed onset of rains and reduced amounts of precipitation increased the risks of farming households who borrowed to invest in farm inputs since the resultant poor harvests would mean that they default on payment of borrowed funds and in the

worst cases, sink into a vicious cycle of debt. This issue is investigated in this dissertation. However, this dissertation focuses on the aspect of vulnerability traceable to environmental stress (and less on macroeconomic issues) so as to gain a deeper insight in face of the limited time and resources available.

Other researchers have viewed vulnerability as being determined by the adverse consequences that remain after the process of adaptation has taken place - what is sometimes called end vulnerability. To Kelly & Adger (2000), vulnerability is the capacity of individuals and social groups to respond to, that is, to cope with, recover from or adapt to any external stress (external because it is not within the power of the individual/social group to completely avert at source) placed on their livelihoods and well-being. Because vulnerability is in a process of constant evolution, Adger & Kelly (1999) stress that 'it is this dynamic aspect of vulnerability that is most important to capture rather than any measure of vulnerability, any snapshot, taken at a particular point in time'. However, adaptation is also a continuous process which cannot be said to be complete at any particular point in time thereby rendering Kelly and Adger's approach difficult to assess with accuracy.

Previous efforts by other researchers have come up with composite vulnerability indices, based on a linear combination of a set of standardized variables, either weighted or averaged, to create a single numeric index (Ramachandran & Eastman, 1997; UNEP, 2000). In this dissertation, the vulnerability of any individual or social grouping to some particular form of natural hazard is considered to be determined primarily by their existent state (by their capacity, or lack of it, to respond to that hazard). The dissertation appreciates Adger & Kelly's view that vulnerability is a state that continually evolves because the technological and institutional factors that shape it are themselves in a state of constant flux and also because humanity constantly experiments with new ways of responding to change. However, just like change, adaptation is also a continuous process and to allude to a stationary point at which the process of adaptation has taken place could be tantamount to either engaging in a perpetually elusive exercise or arriving at a conclusion with strong assumptions.

This dissertation adopts the meaning of vulnerability in the sense in which it refers to the extent to which households or systems can be harmed by environmental stress and declines in natural resources (and by extension, climate change). The abstract noun is used to refer to, the extent to which a system or household is at the mercy of the reduction in the supply of natural

resource goods or climate change. Vulnerability has also been described as the 'capacity to be wounded' (Kates *et al*, 1985) while Rayner & Malone (1998), consider human activities to be sensitive to climate to the degree that they can be affected by it and vulnerable to the degree that they can be harmed. Vulnerability as here used entails an element of defencelessness (possession of a weaker armoury) and/or reliance on a fairly non-secure source of supply of vital resources or commodities.

According to the IPCC (*ibid*), poor communities can be especially vulnerable - particularly those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies. With the expectation that climate change will affect farming (for instance, livestock production) both directly and indirectly, loss of animals through droughts and floods, or epidemics related to climate change may also increase. Temperature is expected to increase globally while precipitation is expected to be reduced in many regions. Whereas heat stress reduces production and reproduction in livestock, the predicted temperature increase is likely to further the expansion of vector-borne infectious diseases (such as the Rift Valley Fever, blue tongue and the West Nile Virus) to high elevations and higher Latitudes. All things unchanged, the projected impacts of climate change on many developing country crops, livestock, forestry and fisheries are likely to be of enormous significance to food security, poverty reduction and protection of the natural resource base in the next decades (synthesis informed by the projections and findings of the IPCC, 2007).

Rural resource poor communities currently face a number of stressors (environmental, economic and social as well as political) which continue to curtail livelihood options and reduce overall quality of life. Going by the observations of the IPCC (*op cit*), climate change in Africa further threatens the livelihoods of such communities. Inappropriate response and adaptation options to risks, including climate stress could further undermine development efforts in the Southern Africa region (Reid & Vogel, 2006). Periods of climate stress, including prolonged drought periods usually unveil a host of factors that contribute to heightened vulnerabilities to environmental change such as deteriorating social networks linked to HIV/AIDS, poor access to basic amenities and resources and a range of wider, structural and governance factors that further accentuate local-scale vulnerabilities (Reid & Vogel, *op cit*). Due to the poverty of many rural households in low income countries, they depend on natural/environmental resources which (given the human population pressure) are

increasingly getting stressed. Arable land, forests, grassland and water sources in many least developed and developing countries are exhibiting signs of stress such as seriously degraded land, seriously eroded soils and drying water sources. Lack of access to safe water arising from multiple factors is a key issue of vulnerability in many parts of Africa. Generally, it has been found that there is large-scale degradation of the natural resource base used for agriculture in the tropics (Oldeman, 1998) with soil fertility depletion being the root cause of food insecurity in Africa (Sanchez *et al*, 1997a, b).

Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. The IPCC (2007) reported that the continent is already showing visible climatic changes and that further change in climate is envisaged. The extreme poverty of many Africans; frequent natural disasters such as droughts and floods; and agriculture which is heavily dependent on rainfall are all parts of the problem.

The IPCC (*ibid*), has espoused that vulnerability to climate change can be exacerbated by the presence of other stresses and that future vulnerability depends not only on climate change but also on the development pathway adopted by people and countries. Certain non-climate stresses can increase vulnerability to climate change (and environmental stress) by reducing resilience and can also reduce adaptive capacity because of resource deployment to competing needs. In reality, vulnerable regions face multiple stresses that affect their exposure and sensitivity as well as their capacity to adapt. These stresses arise from, for example, current climate hazards, poverty and unequal access to resources, soil degradation, food insecurity, trends in economic globalisation, conflict and incidence of diseases such as HIV/AIDS. Meanwhile, it is has become common knowledge that intra- and inter-annual variability of rainfall is a key climatic element that determines the success of agriculture.

Reid & Vogel (2006) contend that understanding and distinguishing between the various drivers or causes of both chronic and transitory vulnerability are also important when trying to understand and manage overall risks to global environmental change. Social factors such as access to information can often aggravate local vulnerability particularly at times of heightened climate stress (O'Brien & Vogel, 2003). Reid & Vogel (2006) raise some critical questions: How does social justice contribute to vulnerability to climate and other stresses? What are the roles of social networks and the influence of various forms of social capital? The two authors assert that there is a need to view the physical and social aspects shaping

vulnerability as two separate entities. Using the Sustainable Livelihoods Framework[8], the two authors identified a number of multiple stressors that served to deepen vulnerability and constrain adaptive capacity in the Muden area in South Africa. These include: The state of institutional organisation, lack of access to information, and governance issues (Reid & Vogel, 2006). As presented in table 2, the two authors worked with some findings of the IPCC – 2001 to highlight certain vulnerability and adaptive capacity concerns.

Among the key concerns raised by the authors are: Low GDP per capita, missing safety nets, stressed coping strategies and the continued dependence on rain-fed agriculture. Reid and Vogel raise issues of vulnerability at meso and macro levels. Even though this dissertation focuses more at the micro-level, it concurs with and incorporates certain views of the two authors in an effort to come up with a robust HACI. The level of awareness which is a function of access to information is worth including as a sub-index of the HACI as also social capital while institutional aspects may be grouped under an external sub-index, an area suitable for further research. Moreover, what Reid & Vogel (*op cit*) refer to as stressed coping strategies can be said to be consistent with weakened household adaptive capacities in the face of negative shocks.

Table 2: Impacts of Climate Variability, Vulnerability and Adaptive Capacity in Africa (After IPCC, 2001)

Likely Impacts of Climate Variability	Vulnerability and Adaptive Capacity Concerns
Increase in droughts, floods and other extreme events will add stress to water resources, food security, human health and infrastructure thus constraining development.	Adaptive capacity is low due to low GDP per capita, widespread poverty, inequitable land distribution and low education levels.
Changes in rainfall and intensified land use will increase desertification (e.g. Southern Africa, Western Sahel).	Absence of safety nets, particularly after harvest failures
Sea level rise will affect coastal settlements, flooding, coastal erosion especially along the south-eastern coast of Africa.	25% of the population living within 100 km of the coasts, vulnerable to extreme events, coastal erosion and sea level rise.
Major rivers are highly sensitive to climate variations; decreases in surface runoff and water could affect agriculture and hydro-electric power schemes thus increasing cross-boundary tensions.	Individual coping strategies for desertification are already strained thus leading to further poverty.
Increase in extreme events in some places, e.g., flooding, rainfall and drought.	Dependence on rain-fed agriculture is very high, and
	Adaptive capacity will be highest in countries with civil order, political openness and sound economic management.

Source: Reid & Vogel (2006)

[8] Sustainable Livelihoods Framework is an analytical framework (used by actors like the British Department for International Development) that promotes systematic analysis of the underlying processes and causes of poverty.

Elsewhere, there have been proposals to use the second generation vulnerability assessments (Füssel & Klein, 2005) and couple adaptation options to the capacity of people to actually implement options that will actually determine their vulnerability to climate change (UNEP, 1998, 2001). In such an approach, a system's or a group's capacity to anticipate, cope with and resist stress as well as the ability to recover from stress are key concerns when addressing vulnerability. The components of vulnerability already identified include: Access to resources, weakening social patterns, degradation of the environment and lack of access to information (Aysan, 1993; Scoones, 2004). On his part, Cannon (2000) identified five key components of vulnerability as being: Initial wellbeing, livelihood resilience, self-protection, societal-protection and social capital (co-operating groups and social cohesion).

Kelly & Adger (*ibid*) outline poverty, inequality and institutional adaptation as vulnerability indicators with certain mechanisms through which they translate into vulnerability. Their approach to vulnerability and its indicators is summarised in table 3 wherein poverty, inequality and institutional adaptation have been given as indicators.

Table 3: Indicators and their links to Vulnerability (Kelly & Adger)

Vulnerability Indicator	**Proxy for**	**Mechanism for translation into vulnerability**
Poverty	Marginalisation	Narrowing of coping and resistance strategies; less diversified and restricted entitlements; lack of empowerment
Inequality	Degree of collective responsibility, informal and formal insurance and underlying social welfare function	Direct: Concentration of available resources in smaller population affecting collective entitlements. Indirect: Inequality to poverty links as a cause of entitlement concentration.
Institutional adaptation	Architecture of entitlements determines resilience; institutions as conduits for collective perceptions of vulnerability; endogenous political institutions constrain or enable adaptation.	Responsiveness, evolution and adaptability of all institutional structures.

Source: Kelly & Adger, 2000.

A slightly different approach to vulnerability is the situational approach of Wisner (2004) which focuses on everyday life and situations in which people find themselves - in a fashion similar to the Sustainable Livelihoods Framework (SLF). This approach sees disasters and climate stress/shocks as 'normal' circumstances to which communities have to respond (Wisner, 1993; Cannon, 2000). For instance, Wisner (2004) suggests that all people have capabilities of self-protection and group action even though these capabilities are often not used to their fullest extent, if at all, and that these capabilities go beyond what has previously been described as 'coping' and 'adaptation'. Advancing a similar line of argument, Devereux & Edwards (2004) state that, "The people who will be worst affected are unlikely to be passive victims of climate change. Most already live in marginal environments and face weather variability, against which they have developed strategies that are resilient against all but the most severe or protracted shocks".

As can be seen from the review of literature on vulnerability, various authors approach the challenges posed by environmental and climatic changes in slightly different ways. Whereas some see them as drastic changes, others view them as on-going changes that only cause reason for alarm among households once the changes go beyond a given threshold. This dissertation sees Wisner's normal circumstances as being fairly consistent with a certain threshold for the frequency and intensity of the negative phenomena (especially environmental stress and climate change) at or below which households' levels of adaptabilities enable them to adapt. Beyond the threshold, however, (and the threshold appears to have been passed in many rural areas in African countries), household wellbeing is significantly disrupted. The strategies spoken about by Devereux & Edwards (2007) appear to be no longer adequate to protect many of the rural households against the prevalent negative impacts from environmental stress and weather variability. As such, there is need to identify and promote effective strategies among households with low abilities for independent adaptation.

It is fairly clear that ongoing environmental stress and climate change impact communities living in various regions of the Earth in diverse ways. Some communities like coastal ones already face chronic vulnerability to climate and environmental changes (due to coastal flooding, rise in sea levels and other weather calamities) while others like rural farming communities face chronic vulnerability to climate variability and other aspects of environmental stress (these are related to the global climate change in explainable ways)

which disrupt farm-based livelihoods. Other socio-eco-political stressors also interact with or add to environmental and climatic problems to occasion or deepen chronic or transitory vulnerability among households.

In a nutshell, drivers of both chronic and transitory vulnerability to environmental stress/climate change in rural areas of many developing countries include physical aspects such as degradation of the environment, droughts, floods and unpredictable weather patterns; and social aspects such as low levels of livelihood, low adaptive capacity, weak institutional organisation (insecure common property rights and entitlements), lack of access to information, poor governance, limited access to resources, weak social capital and inequality in distribution of income and opportunities (social justice issues). Shocks such as political crises, incidence of diseases such as HIV/AIDS and long term illnesses like tuberculosis make up additional factors. It is fairly clear that, some drivers of vulnerability are overarching to meso and macro-levels of analysis.

From a different perspective, limited economic resources, low levels of technology, poor information and skills, poor infrastructure, unstable/weak institutions, inequitable empowerment and inequitable access to resources are associated with low adaptive capacities hence also associated with high vulnerability. The mechanisms of some of the causes or drivers of vulnerability identified in the available literature are briefly described below:

1. Degradation of the environment: As earlier illustrated in figures 1 and 2, degradation of environmental and natural resources affect household livelihoods to the extent that the households are left with increasingly weaker resource bases *ceteris paribus*. Excessive soil erosion, leaching, soil infertility, aridity and loss of biodiversity negatively impacts household food production. The wellbeing of the households is thus threatened in cases of continued degradation of the environment and this contributes to vulnerability. This turns out to be a key source of vulnerability for numerous farming households especially in combination with other drivers such as unpredictable weather.

2. Unpredictable weather patterns and shocks such as droughts and floods: As long as the prevalent weather remains unpredictable the livelihoods of households which mostly rely on rain-fed farming also remain unpredictable and to this extent, such households are vulnerable.

3. Low levels of livelihood: Particular characteristics of an individual, household or community affect entitlements, and therefore, vulnerability (Kelly & Adger, 2000). A low level of living (poverty) is directly linked to the level of access to resources and the process of marginalisation (though wealth is not in itself a guarantor of security as resources are mediated through property rights).

4. Low adaptive capacity: A lower ability to adjust to environmental changes/diminishing natural resources is consistent with a higher vulnerability to the changes in question. Degraded soils, deforested surroundings and erratic weather patterns threaten more, those households which are in weaker positions to adopt alternative strategies to earn their livelihoods or to cushion themselves in the face of the changes around them.

5. Weak institutional organisation and poor governance (this has a bearing on common property rights and entitlements): Poverty, use of resources and the distribution of wealth and income are all institutionally determined. Institutional context refers to formal political structures, 'rules of the game' and socio-cultural norms (Kelly & Adger, 2000). Slow or expensive processes of acquiring title deeds may, for instance, hinder a household's effort at diversification into non-farm income generating activities which may require bank loans.

6. Lack of access to information: Being aware of the changes taking place and the associated implications is significant to the extent that knowledge/understanding/information is a prerequisite for appropriate response. A household that lacks information on the changes and the alternative adaptation strategies may find itself in a very precarious condition where its very existence is severely threatened. On the other hand being aware of the prevalent changes hold a potential of stimulating the search for or institution of adaptation strategies.

7. Weak social capital: Social capital in its diverse forms may be considered as crucial quasi insurance (safety nets) especially in the absence of formal public programmes to cushion individuals in times of extreme hardship. As such, weak social capital implies that the concerned households are exposed to heightened threats because, compared to other households with stronger social capital, these households may be devastated (may not easily recover) in case environmental/climatic changes and/or declines in natural resource supplies significantly impacts their livelihoods.

8. Inequality in the distribution of resources and opportunities (social justice issues): Increasing inequality within a population can heighten collective vulnerability *ceteris paribus*. Greater inequality maybe associated with a reduction in communal resource allocation and in the pooling of risks and other social phenomena associated with the moral economy. In addition, there are strong links between inequality and a lack of diversification of income sources as well as with poverty thereby placing further constraints on response options (Kelly & Adger, 2000).

However, as Uitto (1998) found out, the determinants, drivers and/or causes of vulnerability are neither mutually exclusive nor are they independent of each other. Vulnerability varies spatially and temporally because (national environments, housing and social structures vary) and (people move through different life stages with varying mixes of resources and liabilities thereby creating space for other causes, drivers and determinants. In deed, the field research undertaken for this dissertation among rural households in Kakamega district of Kenya established some empirical support for the causes and drivers of vulnerability identified during literature review as well as other location-specific causes and drivers.

2.4 Adaptation and Coping Strategies

Adaptation in unmanaged natural systems is mostly autonomous and reactive but there is another form of adaptation consciously undertaken by humans, such as those that take place in economic sectors, managed ecosystems, resource use systems, settlements, communities and regions (Smit & Pilifosova, 2001). Adaptation depends on adaptive capacity (that is often built over time) which is, as will be seen later, partly determined by the socio-economic characteristics of a household or community. Enhancement of adaptive capacity reduces vulnerability and potentially promotes sustainable development.

The enhancement of adaptive capacity facilitates coping with environmental and climatic changes and uncertainties including variability and extremes. Autonomous/spontaneous adaptation often takes place invariably in reactive responses to climate stimuli without the intervention of a public agency while planned adaptations can either be reactive or anticipatory and is often the result of a deliberate policy decision on the part of a public agency based on an awareness that conditions are about to or have changed and that actions are required to minimise losses or benefit from the opportunities (Smit & Pilifosova, *op cit*).

Poor and landless households often have limited resources, yet their failure to adapt can lead to significant deprivation, displacement, morbidity and mortality. As Moser (1996) says, the 'poor mobilize and transform their assets both by intensifying existing strategies and developing new ones'. Generally, strategies commonly used by households for coping with vulnerability include social capital, income raising (selling labour) and consumption modifying strategies. Consumption modifying strategies are also often adopted by the poor in the event of declines in income with the concerned individuals cutting total spending, changing dietary habits and/or cutting back on the purchase of non-essential goods (Moser, *ibid*). Apart from the reduction in expenditure, the poor also develop strategies around assets that generate non-monetary resources (Moser, 1996).

Even though subsistence farmers do not have the same adaptation options as commercial producers, some writers have observed that most sectors, regions and communities are reasonably adaptable to changes in average conditions. Smit *et al* (2001) postulate that communities are more vulnerable/less adaptable to changes in the frequency and/or magnitude of conditions other than average, especially extremes. Unfortunately, autonomous adaptation has not been sufficient to offset damages associated with temporal variations in environmental and climatic conditions. The ecological, social and economic costs of relying on reactive, autonomous adaptation to the cumulative effects of environmental stress and climate change are likely to be high.

Experts contend that more planned anticipatory adaptation is necessary and has the potential to reduce vulnerability and realize opportunities associated with climatic and environmental changes. Such anticipatory adaptation efforts would in essence build the adaptive capacity of households and regions. Since the costs of adaptation are often marginal to other management or development costs, adaptation measures are more likely to be implemented if they are consistent with or integrated within decisions or programs that address non-climatic stresses. Indeed, IPCC (2007) notes that adaptation measures are seldom undertaken in response to climate change alone but can be integrated within, for example, water resource management, coastal defence and risk-reduction strategies.

The capacity to adapt varies over regions, countries and socio-economic groups and will vary over time. The most vulnerable groups at any point in time are those that are exposed to hazardous environmental stress and climate change effects and have limited adaptive

capacity. Limited economic resources, low levels of technology, poor information and skills, poor infrastructure, unstable/weak institutions, inequitable empowerment and inequitable access to resources are associated with low adaptive capacity/high vulnerability. This makes the enhancement of adaptive capacity a necessary condition for reducing vulnerability, particularly for the most vulnerable regions, nations and socio-economic groups.

Fortunately, the activities required for the enhancement of adaptive capacity are, in many cases and ways, equivalent to those promoting sustainable development. The inclusion of climatic risks in the design and implementation of development initiatives therefore may be considered to be a crucial step in order to reduce vulnerability and enhance sustainability. In this case, it is just as important to identify how adaptability can be improved as it is to identify the physical climatic impacts (Eriksen, 2001). Since there are spatial and temporal variations concerning the impacts of climate changes, there are various possible effective measures to reduce vulnerability since social conditions change. Mohanty (2007), for instance, observed that poor urban households in Fiji were using informal sector employment, social capital and consumption modifying as well as income raising strategies to cope with environmental, socio-economic and health vulnerabilities.

In their contribution, Reid & Vogel (2006) observe that the design and effective implementation of strategies to improve coping and adaptation to possible future risks cannot be undertaken without a detailed assessment of current response options (possibilities) to various risks. The two authors used the Sustainable Livelihoods Framework (SLF) to identify some of the strategies (and constraints) for the securing of livelihoods that were being used by small-scale farmers in the Muden area of KwaZulu-Natal in South Africa. A mix of adaptation strategies for some of the cultivators in the area included outside employment/temporary migration and reciprocal obligation. Reid & Vogel (*op cit*), identify different actors at various levels (see annex 3a) which play roles in improving resilience, coping and adaptation. The two authors place household sale of labour, consumption modification, group membership, use of loans, diversification and migration among coping and adaptation strategies. Elsewhere, Downing *et al* (1989) espoused that in Kenya effective small holder response to drought has shifted from traditional planting strategies to employment diversification while Ominde & Juma (1991), observed that measures that are likely to reduce current sensitivity to climate variations in Africa are also likely to reduce the threat of adverse climate change impacts.

Climatic changes currently prompting adaptation include changes in average annual conditions - variability and extremes. The IPCC (2007) notes that cases of remarkable resilience in the face of multiple stressors have been shown. Eriksen (2000), displays a study from two arid agricultural areas in Kitui district in Kenya and in Same district of Tanzania which show that biodiversity in the form of local tree and plant species distributed throughout the farms present an alternative income for poor farmers when crops fail (often due to reduced rainfall). He adds that local wood is used to make stools, kitchen equipment; chicken coops and so on – products which are sold at the local markets while charcoal is burnt from lumber and then sold to urban areas and cities. Besides these, certain tree leaves and seeds are used as cattle feed and drought resistant indigenous fruits constitute an important source of nutrition for both children and adults when there is little food. In such ways, preservation of local knowledge and biodiversity in cultivated areas helps enhance adaptability and reduce vulnerability to extreme environmental conditions and climate events such as drought and flooding (Eriksen, 2000). Such micro level initiatives should be complemented by macro level ones.

At the macro level in Kenya public efforts directly aimed at helping households to cope or adapt to the changing environmental and climatic conditions have mainly in the form of awareness creation and weather forecasting while major focus has gone to poverty alleviation through the improvement of credit provision. It may be expected that poverty alleviation through enhanced credit provision eventually supports adaptation but even in this area, there have been key challenges.

In its 2006/2007 budget the Kenyan government allocated KES 1 billion to the Youth Development Fund in its effort to promote young entrepreneurs. This was followed by the launch of a KES 1 billion Women Fund in 2007 to promote women enterprises. In the same year, Equity Bank Kenya Limited partnering with UNDP, unveiled the National Strategy for Promotion of Women in Business and Investment. However, unborrowed funds have been observed to exist alongside deep poverty in a significant number of regions in Kenya. During a field research exercise carried out by the author in 2007, in Kakamega district for instance, it was observed that a significant number of people, businesses and potential entrepreneurs avoided taking credit for fear of losing their property which would in such a case, be attached as collateral security (Mwamba, 2007). Some stakeholders, like Dr James Mwangi of Equity

Bank have also expressed doubt as to the effectiveness of the credit lending activities of some micro credit organisations given the high interest rates charged (Mwangi & Omollo 2007).

At another level, the Kenya National Dialogue and Reconciliation Monitoring Project (2009), observed that the efforts that seek to address unemployment among the youth narrowly focus on entrepreneurship without regard to the fact that not all youth are well organised to access the funds for entrepreneurship. A number of local experts (such as Okoth Opiyo of Erudite Consultants) have also criticised Kenyan MSMEs promotion initiatives for emphasising too much on funding/credit provision rather than capacity building. Such critics note that most potential applicants and recipients lack the capacity to understand, plan and implement entrepreneurial intentions. The experts ground the observed fear of credit on lack of understanding of how to successfully and profitably handle loans. They assert that the availability of funds without emphasis on entrepreneurial and business development training could result in failure not only for banks and micro-finance institutions (MFIs)[9] but also for enterprise promotion initiatives and the intended beneficiaries. When an inadequately prepared loan beneficiary defaults and the attached property (say land) is lost, this development foments the fear of credit among other potential applicants.

At an international level, Thomas Dichter (2007) terms as unrealistic, the expectation that the microfinance movement would provide funds for investment in micro businesses, thus lifting people out of poverty and promoting economic growth. He relies on the historical experience of industrialised countries, and points out, “Today as in the past, business start-ups in the advanced countries depend predominantly on savings and informal sources of credit. Past forms of micro credit never played a role in small business development and much of the micro credit is actually used for consumption rather than investment”. If this were the general case, then micro-finance or micro-credit could be deepening poverty and therefore weakening long-term adaptive capacity. In later sections, this dissertation explores this issue using evidence from field research. Apart from the use of credit, there are other adaptation strategies mostly promoted by meso organisations in various parts of the world. Some of these are presented below.

[9] MFIs refer to micro finance and micro credit institutions as well as organisations, programmes, projects and initiatives for the promotion/development of enterprises.

In Mali, the people of Douentza were faced with crop failure due to a stressed environment at the edge of the Sahara desert. Assisted by a private organisation – Seeds of Survival (SOS), they swapped larger animals for sheep and goats that were easier to handle in the changing environment. They also carved half-moons on the soils and built a basin to conserve water. The women set up market gardens, using the rainwater basins to irrigate vegetables that were then sold in local markets. Seeds of Survival helped farmers launch community seed banks where farmers have access to locally-adapted crop varieties (USC Canada, 2008).

Another set of examples of adaptation strategies comes from a project called "Sustainable Development and Ecological Land Management with Farming Communities in Tigray" in Ethiopia. Here, farmers were faced with numerous challenges including drier and degraded soils (thanks to overgrazing, deforestation, shortage of land and urbanisation), serious soil erosion, droughts and food insecurity. The bundle of response strategies brought forward by the Tigray Project included: Making and using compost manure; restricting grazing and/or encouraging cut and carry to feed livestock; making trench bunds for catching both water and soil; planting small multi-purpose trees – particularly *Sesbania sesbans* and local grasses; halting and rehabilitating gullies; making ponds; besides making and using by-laws to control access to and use of local biological resources including the restriction for grazing animals (Araya & Edwards, 2006).

Within the same Tigray project, the Adi Abo Mossa group confronted the threat of eutrophication of Lake Hashenge due to the use of chemical fertiliser by adopting the making and use of very good quality and higher quantities of compost manure. Among the benefits demonstrated were increased yields and overall biomass productivity; soil and water conservation; pest and disease control; improved soil fertility and longer retention of soil moisture; rehabilitation of degraded lands and increase in farmer's incomes. The authors report that there were observable socio-economic benefits of the Tigray Sustainability Project in the lifestyles of farmers who had adopted the use of compost manure. Several farmers including women-headed families had improved their housing, bought additional livestock such as chicken and dairy cattle besides establishing beehives. Many farmers also diversified their crop production. Generally speaking, in all the project sites, the environment was rehabilitated, food and feed production greatly improved, tree and grass cover returned and ground cover increased (Araya & Edwards, 2006). After the construction of a series of check dams in the gullies, and in just one year, sufficient soil had been captured for grasses and tree

saplings to grow on. By 1999, a permanent spring had appeared and as from 2005, several farmers downstream have been able to harvest at least two crops a year using the water for irrigation. Many farmers have reportedly now started planting fruit trees both around their homesteads and in rehabilitated gullies. Due to increased demand, a new tree nursery was being developed. An organic production management system offered a real and affordable means to break out of a poverty trap, obtain food security, have a better livelihood and conserve the environment and thereby moderate climate change.

These examples serve to illustrate the potential for multi-action strategies at the meso and micro levels. Addressing the meso and macro levels, some researchers (like Ogunlade *et al*, 2003) have stated that, since the realisation of development goals may be hampered by climate change, a future climate regime should focus on development strategies with ancillary climate benefits. While observing that development issues related to food, water and energy are clearly related, the researchers argue in favour of more inclusive action plans. Looking at the MDGs promoted by the UNDP and the Poverty Reduction Strategies of the World Bank, Ogunlade *et al* (*op cit*) criticise them for not including assessments of the links between development and climate change. To Ogunlade *et al* (*op cit*), this omission implies that the potential stresses and constraints which the future climate change and variability will impose on the development opportunities are not taken into consideration. Those authors further regret that the possibility of achieving joint benefits through co-ordinated development and green house gas (GHG) emission reduction policies are not identified. This is a typical call for a sustainable development[10] approach. Sustainable development – development which lasts (incorporates economic, social & environmental aspects). It is one that permits continued improvements in the present quality of life at a lower intensity of resource use, while leaving behind for future generations, enhanced stocks of assets (that is, manufactured, natural and social capital) that will provide undiminished opportunities for improving their quality of life with key emphasis on improving system health and the dynamic ability to adapt to change across a range of spatial and temporal scales.

[10] Looking at sustainable development in close association with the Bioeconomy model (which has 3 concentric circles: Environment, Economic, Social), Lehtonen (2004) follows a socially sustainable development through as one that guarantees for both present and future generations an improvement of the capabilities of well-being (social, economic or environmental) for all, through the separation of equity on the one hand – as intra-generational distribution of these capabilities – and their transmission across generations on the other hand (Ballet *et al*., 2003).

With regards to global warming, it has been observed that many African policy makers and institutions have exhibited less than satisfactory effort towards controlling GHG emissions or adapting to changes in climate. Ogunlade *et al* (*op cit*) observe that this attitude is based on the policy makers' experience that, in general, other, more local, environmental problems have more direct influences on their populations than climate change such that: In strongly degraded areas, efforts are geared towards immediate rehabilitation of the most productive and cultivable areas by focusing on the prevention of soil degradation & bushfires and encouraging reforestation. For areas with erratic and low rainfall, where timing of soil and crop management determines success or failure of the growing season, efforts have mostly been geared towards searching for more suitable crop varieties, precision management of resources and implementation of weather-information-based support systems (Ogunlade *et al*, *op cit*). This scenario calls for a reconciliation of the immediate priorities with more long term objectives presented by the environmental and climate change threat.

Another factor which may explain the relatively weak efforts by African governments may lie in the fact that current African GHG emissions are practically negligible due to the low level of development and industrialisation compared to global standards. The entire continent is estimated to be responsible for less than 7 per cent of global emissions and only about 4 per cent of CO_2 emissions and therefore the contribution to mitigation of global emissions by Africa can only be limited (Davidson *et al*, 2003). Despite being responsible for very little of the anthropogenic GHG emission, Africa holds considerable potential to help reduce them through export of Biomass or hydropower or even to absorb them through sustainable forestry. These are issues that deserve appropriate attention. Since environmental stress at local levels occasion vulnerability and fuel global climate change, any improvement to the handling of the environmental/natural resources may be expected to yield net social benefits. Any adaptation by households to face environmental stress and declines in natural resources is a partial adaptation to global climate change.

According to the African Development Bank *et al*. (2003), it may be generally argued that the livelihood resources and response options of the poor are usually narrower and more climate-sensitive than the non-poor. Due to this, the most pressing challenge is to strengthen the social, economic and environmental resilience of the poorest and the most vulnerable against climate change and variability (Fischer *et al*., 2002). Strategies designed to boost the ability of poor households to adapt to changing environmental and climatic conditions could therefore

actually save lives by properly targeting the ones with the narrowest response options. At the core of this dissertation is the development of a tool for the identification and targeting the households with the narrowest response options. The following section presents a review of literature in the area of household adaptability.

2.5 Household Adaptability

As has been mentioned, the assessment of household level adaptability and the associated concept of household adaptive capacity may constitute the first step towards enhanced adaptation and/or mitigation. Adaptability was already defined in chapter one as the ability to adapt or adjust to changes in environmental and climatic conditions. Adaptability and vulnerability are closely linked with the former reducing the latter and the latter having a weakening effect on the former over time. Adaptive capacity on the other hand refers to the extent to which a household/system possesses features, qualities or characteristics that bestow a capacity (through the possession of tangible and intangible assets) to adapt or adjust to environmental stress, climate change stimuli or their effects or impacts. The characteristics of a household or society determine its adaptive capacity and its adaptability.

Adaptive capacity connotes a state of being prepared or an ability to quickly prepare for hazards and opportunities in advance (as in anticipatory adaptation) and to respond or cope with the effects (as in reactive adaptation). Adaptive capacity includes both the ability to cope or react in the short term as well as adjust in the longer term to environmental and climatic changes and the effects of the same (Schjolden, 2003). Enhancement of adaptive capacity can be achieved through a number of strategies such as those that build resilience. The term ‘resilience’ as used here refers to the ability in resisting or recovering from the negative effects of a changing environment or climate. The means of resistance are (often) the various types of assets that a household can mobilize in the face of hardship (Moser, 1996). The more the capital assets a household possesses, the greater is its capacity to resist or withstand threats or vulnerabilities.

With respect to global climate change, simulations suggest rising relative benefits of adaptation with low to moderate warming, although adaptation may stress water and environmental resources as warming increases (IPCC, 2007). According to the IPCC (*ibid*), smallholder and subsistence farmers, pastoralists and artisanal fisher folk are likely to suffer complex, localised impacts of climate change. Such groups have to develop a capacity to

adapt to the constantly changing environmental and climatic conditions if their continued existence is to be guaranteed.

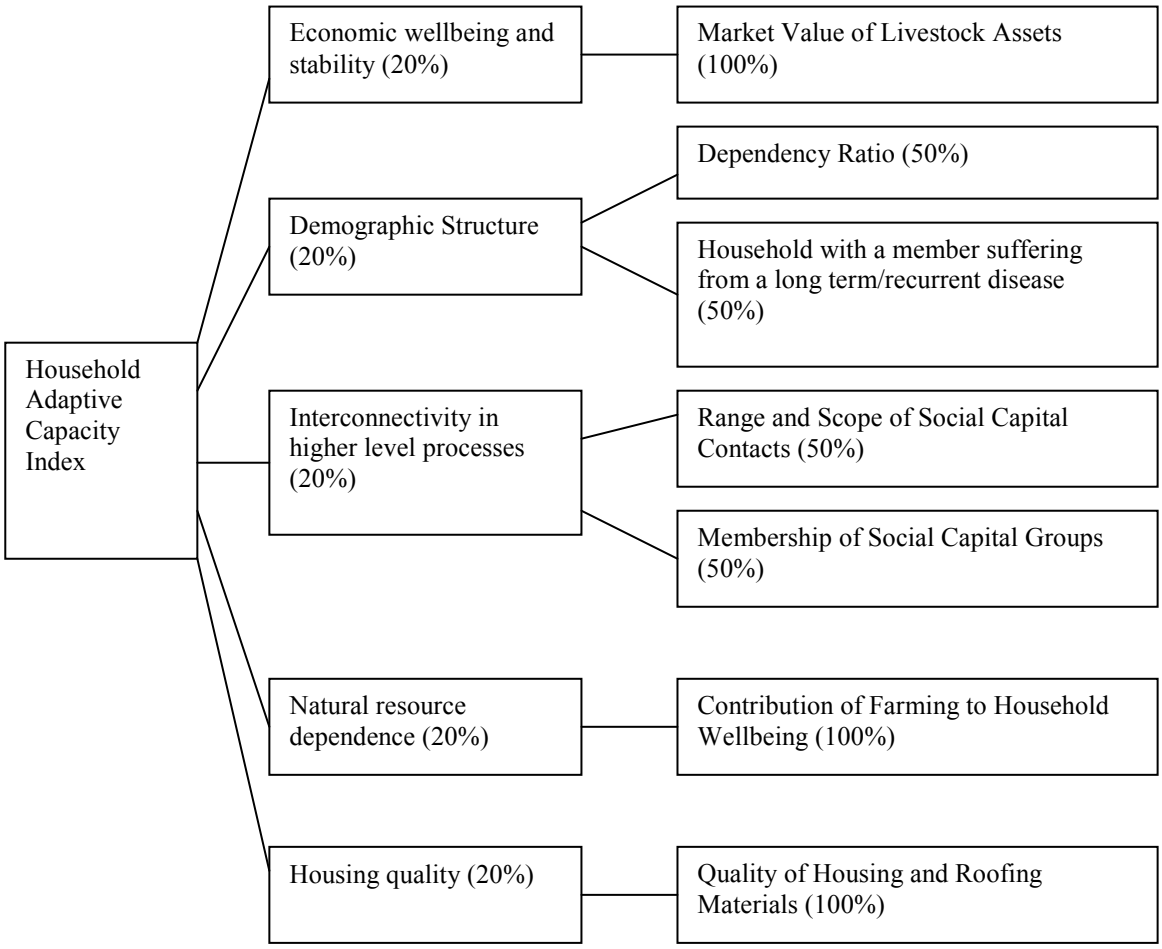
Given the emerging cases of serious environmental stress, many development experts contend that adaptability is best achieved in a framework of sustainable development (explained in the section on adaptation). With the help of the knowledge on the adaptive capacity of households, a more accurate assessment of their ability to adapt (adaptability) can be achieved and any existing deficits identified for bridging. Indices and indicators have been popularly used to empirically assess the determinants of vulnerability, and therefore, to facilitate the comparison of adaptability at various levels. Available literature shows that a number of indicators and indices have been attempted for small island developing states (Briguglio, 1995; Crowards, 1999; Kaly *et al*., 1999; Easter, 1999).

Comparing the National Adaptive Capacity Index (NACI) developed for cross-country comparison in Africa and the Household Adaptive Capacity Index (HACI) developed for cross-household comparison in a rural dry land setting in Limpopo province, South Africa, Vincent (2006) presents sub-indices combining both the composite and aggregate approaches that give a final index in form of an aggregate figure (made up of a number of composite sub-indices). The indices in (Vincent, *op cit*) result from a theory driven indicator choice (to capture theoretical determinants of adaptive capacity based on literature and expert judgement) and a weighting process (to reflect the relative importance of each determinant). The final indices refer to the current status of adaptive capacity.

As illustrated in figure 4, the HACI in Vincent's work is formed from the weighted average of five composite sub-indices: Economic wellbeing (20%); demographic structure (20%); interconnectivity in higher level processes (20%); dependence on natural resources (20%); and quality of housing (20%). As Vincent rightly notes, using the current status has been identified as a suitable proxy and one that is appropriate for identifying the means of increasing future adaptive capacity (Adger & Kelly, 1999; Adger *et al*., 2003). However, the decision to apportion equal weights (20%) to all the chosen sub-indices is, in the view of this dissertation not optimal since some sub-indices such as economic wellbeing, are broad and therefore likely to encapsulate factors which are likely to be worthy of more weight than others. Moreover, for areas other than that for which it was developed, the index, as presented

is inapplicable (for instance, among employee households or crop farmers given that livestock possession was used as the only indicator of economic wellbeing).

Figure 4: Structure of the Household Adaptive Capacity Index (HACI) in Vincent (2006)



Source: Vincent, 2006

Others have used socio-economic scenarios to capture how adaptive capacity can change over time (Moss *et al.*, 2000) but this practice is still clouded with relatively more uncertainties than the alternative practice of using current status as a proxy for the future. It is clear though, that coping and adaptive strategies are being influenced by the dynamics of a variety of social and institutional systems and the capacity of the community and households to use available resources and assets at their disposal. Using the Sustainable Livelihoods Framework, these assets have been identified by other researchers to be human, social, financial, physical and natural[11] (Reid & Vogel, 2006).

[11] Human capital: A given quantity and quality of labour is required to work with the other forms of capital. Social capital: The social resources upon which people draw in order to pursue livelihood activities (DFID, 1999): Networks and connectedness, membership of formalised groups & relationships of trust, reciprocity and

Given that vulnerability and adaptation to environmental and climatic changes are highly variable and strongly tied to local places and local contexts (adapted from Leichenko & O'Brien, 2002), the research behind this dissertation recognised the contribution of the previous studies (especially Vincent's) but proposed that more accuracy could be gained by incorporating other sub-indices and/or indicators and a different design of weights based on empirical evidence besides theory and expert judgement.

The modifications are presented below and the pattern of quantification is presented in the next chapter. The Sustainable Livelihoods Framework (SLF) - also used by Reid & Vogel (2006) – provided additional support in the selection of indicators for an improved adaptive capacity index. Sustainable Livelihoods Framework (SLF) is one that is primarily concerned with people and how their assets in the form of various 'capitals' (for instance, social, physical and natural capital) enable them to achieve positive livelihood outcomes (DFID, 1999). This framework facilitates the understanding of some of the interacting factors that shape how communities respond and interact with climate variability and other stresses.

Previous research experience among the rural households was synthesised with available literature in efforts geared towards the development of a household adaptive capacity index similar to that in Vincent's work (*ibid*) but improved and adjusted to more appropriately capture rural household adaptive capacity to environmental stress and climate variability. The following factors are the result of the synthesis of information from literature review and insight gathered from field research in Kakamega district of Kenya. The factors effectively form the sub-indices of the HACI which has been put forward by this dissertation. These sub-indices (factors) in turn have specific indicators (variables) used to pick up and quantify the important characteristics for household adaptive capacity.

1. Economic wellbeing and stability: This is one of the key factors determining the capacity of a household to adapt to environmental stress or climate change through a direct relationship. The role of assets in enhancing adaptability features significantly in both the Sustainable Livelihood Approach (SLA) – developed by the UK Department for International

exchange. Natural Capital: Natural resource stocks that are useful for livelihoods e.g. land, forests, water, biodiversity, erosion protection. Physical Capital: Basic infrastructure and producer goods needed to support livelihoods e.g. dams & tractors. Financial Capital: Financial resources used by people in order to sustain or better their livelihood. These are flows of cash and stocks, e.g. cows, cars, houses. Off- and on-farm income besides stocks of resources can be used in the assessment.

Development (DFID, 1999) and the Household Livelihood Security (HLS) approach developed by CARE (cited in Sanderson, 2000). The latter approach for instance, emphasizes the need for sustainable and adequate access to income and other resources to meet basic needs and to build up assets to withstand shocks and stresses. Here, various capital assets: Social, human, financial and physical / productive assets act as an important strategy through which the poor cope with their vulnerabilities. The poor are often powerless socially, economically and politically with this lack of power reducing access to resources and in turn narrowing the range of options available in times of stress and thus making them more vulnerable. The livelihood approaches aim at building strengths of the poor to withstand risks. Focus is directed to factors that have poverty reducing potentials such as social networks, access to physical resources and ability to influence institutions.

Given the positive role of asset accumulation in poverty alleviation, factors promoting or hindering asset building have enjoyed increased interest. According to the findings of Muyanga *et al* (2010) in Kenya, households successfully accumulating assets and rising out of poverty (i) were more likely to have remained healthy and suffered no unexpected deaths during the decade prior to the start of the initial survey in 1997; (ii) were less adversely affected by mortality that did occur during the panel period compared to other households; (iii) were consistently headed by a male; (iv) received relatively more land from their parents at the time the household was formed; and (v) had parents who were relatively well-off and educated. Moreover, the ascenders (households with improved livelihood bases) were able to acquire more land, cultivate 70 per cent more land, and increase their use of fertilizer over the 2000 -2007 period.

Among households reporting a significant decline in asset wealth, roughly half experienced unexpected shocks, such as premature death and chronic illness (Muyanga *et al*., 2010). The authors added that these households reported spending 22 per cent of their annual incomes and 47 per cent of their assets on medicines and care-giving. Households with declining asset trajectories were also more likely to have turned from male to female-headed due to male mortality, have two or more wives in the household, poorly educated household heads, have fathers or household heads who were relatively uneducated, and have relatively little land and other assets inherited from parents. The descenders (households with weakened livelihood bases) also tended to lose land and animal assets over the panel period (in some cases due to disease and need to pay for medical expenses) in sharp contrast to the ascenders. Perhaps

surprisingly, the descenders were more likely to use fertilizer, had higher fertilizer application rates per acre cultivated, and were more likely to receive agricultural credit than the ascender households.

Tangible and intangible wealth such as livestock ownership, land ownership and the household pool of skills can also be seen as a permanent source of income (for instance through farm sales and rents) and a store of value from which the members draw over time. The means of resistance to environmental changes are the assets that a household can mobilize in the face of hardship (Moser, 1996). The more capital assets households possess, the greater is their capacities to sustain and resist vulnerabilities or threats. This is considered to have a key contribution to the HACI because even in times of stress, households first rely on their assets – disposing them in order of reducing value so as to pull out of the hard times. In many African societies, livestock represent an accumulation of wealth.

The market value (in Kenya shillings – KES[12]) of assets including land, household durables and livestock (cattle, goats, donkeys, pigs and chicken) therefore constitutes one of the indicators used to capture economic wellbeing in the improved HACI. Livestock and household durables provide the very immediate weapons in times of stress. Some households may lack land but most of them commonly own some durables and/or livestock on which they can rely. Cattle Equivalent Units (CEU) based on mean price ratios between different livestock types (for instance, ox = 1, pig = 0.28, goat = 0.14, sheep = 0.10, turkey = 0.04, chicken = 0.02, others = actual price/mean ox price) have been used for valuation (similar approach to Ellis *et al.*, 2003).

The household land possession or ownership also plays an important role as relates to stability and wellbeing. In many African countries, land remains the primary factor of production for a majority of households even though some are landless (African Development Bank *et al*., 2003). Mwamba (2007) and Muyanga *et al* (2010) observed that intergenerational transfer of wealth (such as land) had a significant impact on household wellbeing (poverty level) in Kenya. Moreover, the ability to secure loans is greatly improved by the ownership of land whose title deed could be used as collateral. It may be generally argued that the livelihood sources and response options of the poor and landless are usually narrower and more climate-sensitive than the non-poor or those who own substantial land. As such, **right to land** is

[12] Currency conversion at the time of data collection: €1 ≡ KES 100, $1 ≡ KES 75

another indicator for this sub-index. For many households in developing countries such as Kenya, land possession or ownership is central to continued survival.

In the view of this dissertation, another important indicator of household wellbeing and stability is **income diversification** since it often entails a risk spreading effect. In the Kakamega District of Kenya, previous research by Langer (2005) as well as Lay & Michuki (2006) displayed a tendency to diversify into various economic activities to cushion the households as well as to accumulate assets and therefore boost livelihood. Households with more diversified sources of income are likely to exhibit greater adaptive capacities than those with less diversified sources of income *ceteris paribus*. This is especially the case when economic activities into which households diversify, are less reliant on the same natural resource whose depreciation would threaten the overall income base of the household. Previous research by the author in Kakamega District of Kenya revealed that most household heads in the rural areas of the district had not completed secondary schooling yet another previous research in the same area by Lay & Michuki (2006) shows that levels of education below secondary school[13] have no significant impact on household income. This situation limits the chances of multicollinearity between level of education and income diversification as indicators and accommodates the usage of both as indicators. The dissertation assessed the presence of other significant income sources in the households in the sample (most of which featured household heads with lower-than-secondary-school levels of education) so as to capture income diversification (especially into activities less dependent on sensitive environmental resources) as a contributor to adaptive capacity. To be significant for the purposes of this dissertation, a source of income had to be regularly contributing at least 20 per cent of the total household income.

Education or **training** and **health** of the **household members** are the other significant indicators for household economic wellbeing and stability since education or training embodies a permanent resource from which flows of income may be obtained by households. The skills embodied in a household member (what he[14] can, also viewed in terms of

[13] Field research by the author in 2006 in Kakamega district showed that most household heads had not completed secondary school education. Emigration of educated youths in search of employment in urban areas is likely to have contributed to this situation (leaving a larger proportion of uneducated and less educated).

[14] He: Just like 'man', 'he' has been used to stand for both male and female human beings. This research is as gender sensitive as necessary in this century. The use of 'he' to represent mankind serves the sole purpose of minimising repetition and maximising on the use of space/paper.

individual capabilities[15]) determine to a given extent, his ability to adapt to changing natural/environmental resource conditions as well as climate change. To assess the economic wellbeing and stability of a household without peering into the human resource package within the household is in the view of this dissertation insufficient. In cases of shocks and crises that disrupt household livelihoods, household members sell their (skilled, semi-skilled or unskilled) labour, if they can; before they dispose other household assets like livestock or land. Moreover, when one views labour (any human effort – mental or physical - employed in the creation of utility) as a factor of production, it matters whether or not individuals are in 'good working condition'. For this reason, the state of being healthy and capable of working has positive implications for adaptive capacity and so it is important to take note of the extent to which household members are in "good working conditions".

Mdoe & Ellis (2003), observed that, in addition to land and livestock, the key assets of rural families in Tanzania are their own labour (active adults in the household), their educational attainment (in his case, years of education summed across active adults) and ownership of productive implements and tools (aggregate value). Elsewhere, Reid & Vogel (2006) examined the role and perception of climate risks in relation to a variety of other constraints and risks in the Muden area of KwaZulu-Natal, South Africa and revealed that health status, lack of information and ineffective institutional structures and processes are some of the key factors aggravating current response options and overall development initiatives with potential negative outcomes for future adaptation to periods of possible heightened climate stress. Since good health (asset) promotes adaptive capacity while poor health (burden) hinders the same, the number of healthy household members (adult equivalents) is used as one of the indicators for household economic wellbeing and stability while the number of household members with terminal illnesses is incorporated in the sub-index of dependency burden.

2. Dependency Burden: Households with a high degree of dependency, whether through children, the elderly, the severely disabled or the infirm are likely to have less adaptive capacity since such members present an extra 'burden' to shoulder hence occasioning some level of disadvantage. Previous experience by the author in Kakamega district shows that a relatively high level of mortality was robbing households of key breadwinners and raising the

[15] Individual Capabilities: Alternative combinations of functionings (various things a person may value doing or being – nourishment, shelter, self esteem, community participation) an individual can achieve (Sen, 1999).

number of women- and child-headed households. When important income earners perish, earnings from the few working members are often inadequate to guarantee stable livelihoods with the result that some household assets often have to be sold to bridge income and expenditure gaps. According to the findings of Muyanga *et al* (2010) in Kenya, households with declining asset trajectories were more likely to have turned from male to female-headed due to male mortality. Households with a lower level of dependency would most likely adjust more easily to lost income in case of death of an earning member and may be slower in resorting to sales of household assets as compared to those with higher dependency burdens. Should further shocks appear (for instance, in form of diseases as is common in many rural areas of developing countries), recovery may take much longer and adaptive capacity is likely to decline further for a household with a higher level of dependency.

Dependency level partially determines the speed of recovery in case of negative shocks and the household's ability to cope with further negative shocks. Previous research experience within the BIOTA-Africa project in Kakamega District showed that the incidence of terminal illnesses like Diabetes, HIV/AIDS and Tuberculosis and serious forms of disability had significant negative impacts on household livelihoods. Muyanga *et al* (2010), research findings in Kenya also underscored the importance of staying healthy in the household's ability to accumulate productive assets and move out of poverty noting that households that had become poorer reported spending 22 per cent of their annual incomes on medicines and care-giving. The authors note that households' agricultural performance and earnings over time is in many cases related to their lagged health status. In this dissertation, the incidence of long term illnesses is seen to be making a negative contribution to the HACI via the sub-index of dependency burden. A high incidence of long term/recurrent diseases or illnesses such as cancer, HIV/AIDS, tuberculosis, diabetes, epilepsy and high blood pressure weakens household adaptive capacity. Given the potentially heavy adverse implications a higher level of dependency can create for rural households, this factor has been included as a distinct sub-index within the structure of the improved HACI.

As used here, dependants refer to household members under the age of 18 years or over 65 years (adulthood generally begins at 18 while retirement age in many developing countries range from 55 – 65). According to previous research, the HIV/AIDS pandemic was raising the number of dependants in Kakamega district of Kenya (Mwamba, 2007). In view of the diverse household sizes, dependency levels must be appropriately categorised to bring out any

relative differences with implications on adaptive capacity. It is fairly plausible to expect that the higher the number of non-working or terminally ill household members, the more unfavourable the household characteristics are bound to be and this is in turn, likely to precipitate a weaker adaptive capacity. The number of terminally ill household members and that of non-working household members therefore serve as indicators for the dependency burden within a household. The concept of adult equivalents has been applied during the enumeration of the number of non-working members in the households. Buse & Salathe (1978) showed that household composition has a significant effect on household expenditure with children consuming less total food for instance. Since the (food, shelter and clothing) needs of infants and preschoolers (0 – 6 years), primary school-aged persons (7 – 12 years) and secondary school-aged persons (13 – 17) differ (expenditure on young dependants tends to rise with age as they approach adulthood), different weights (0.25, 0.5 and 0.75) have been applied where dependants (non-working members) were below 18 years of age.

3. Interconnectivity within higher level processes: Those households whose contacts and knowledge are based around the village can be presumed to have less adaptive capacity in the face of adverse environmental changes and climatic exposure than those whose networks extend over a greater geographical range and connect with a wider variety of institutions (Adger, 2003). It may be expected that, the greater the social capital[16] of a household, the more likely they are to have contact with more worldly persons who are more aware of better or increased opportunities and alternatives. The indicators of this sub-index include: The **geographical scope of contacts,** the **number of groups** to which a household member belongs and the **number of social categories** a household relies on in cases of shocks (this can also be viewed as level of diversification of social capital contacts). Contacts within the same geographical region are bound to be equally affected by environmental stress or climatic changes prevalent within the locality in question and may therefore be of little help to a vulnerable household (since both parties would be facing the same threat). In case of localised environmental stress problems, contacts in far geographical areas which are less affected by

[16] Social Capital (SC): Networks of social relations characterised by norms of trust and reciprocity that can improve the efficiency of a society by facilitating co-ordinated actions. The horizontal dimension of SC includes bonding and bridging SC. Bonding SC are those involving – family members, close friends, relatives & neighbours while bridging SC involves more distant friends, associates and colleagues. The vertical dimension is also referred to as linking SC. It entails the capacity to leverage resources, ideas and information from formal institutions beyond the community (Woolcock, 2001).

the threats in question may offer more reliable assistance (in form of food or money for instance).

Another important aspect is that rural households networking with persons located in urban centres (near public and commercial services) tend to have better access to critical services[17] and enjoy certain advantages not accessible to households without such contacts. With this in mind, the more the number of contacts a household has in urban areas and other geographical areas away from that in which the household in question is located, the stronger the level of interconnectivity and hence the higher the adaptability of such households is likely to be. For geographical scope of contacts, the possession of contacts, located in urban and other distant areas (at least 50 km away) has been observed to be of importance and therefore worth assessing.

It has also proved to be important to capture the social categories of a household's contacts, that is, the extent of access to both bonding social capital (kin and friendship ties) and networking social capital (traditional and formal governance structures). A household which can only rely on an uncle (family) but neither on friends nor employer may have no where to turn to in the event of a negative shock where the uncle (family member) cannot assist at that particular point in time. In such a scenario, a household with more social groups is likely to be better off. The higher the number of (different) social categories a household relies on during shocks, the better the interconnectivity of such a household (hence the higher its adaptability is likely to be). This may also be viewed as the level of diversification in a households social capital contacts.

The number of groups to which a household member belongs is another important dimension. Among the rural households, this is an additional indicator contributing to adaptive capacity in two ways. Firstly, membership in local groups - which can include burial societies, women's wheels[18] and savings groups – may constitute a measure of the range of social safety nets to which a household has access. It has been found that farmers and local community groups are among the key organisations that are critical to ensure possible resilience to

[17] In Kenya for instance, the author's observations reveal that households pursuing services or documents like retirement benefits, title deeds, birth or death certificates often rely on contacts for information, guidance or even temporary accommodation as often happens while seeking treatment at the few referral hospitals.
[18] Women's wheels refer to women groups brought together by a need to pool funds for individual or group projects as is often the case with rotating savings and credit associations (ROSCAs).

changes (Reid & Vogel, 2006). Additionally, the entire range of these groups, but burial societies in particular, function as a kind of informal grass roots insurance, the type of which would be crucial in the case of a climatic-related risk exposure or adverse environmental catastrophes. Secondly, membership often entails regular fee payments, and so the mere fact that a household can afford to and actually decides to pay this reflects its economic priorities.

Depending on the types of members a group has, interaction with group members may also promote the sharing of useful information for adaptation. Holding other factors constant, it seems rational to expect that the higher the total number of groups to which at least one household member belongs, the higher the number of alternatives such a household is likely to have in cases of negative shocks and the better its adaptive capacity in face of environmental changes. Besides this, the more diversified a household's pool of contacts is (made up not only of family members and friends but also civil servants, industry experts, educationists among others), the lower the likelihood that the household could be devastated by a negative shock. A more diverse pool is likely to be beneficial to adaptability since this raises the likelihood of obtaining information and assistance faster than otherwise even in cases of more widely spread negative shocks.

4. Susceptibility to environmental changes: The more a household depends on environmental/climate change sensitive resources, the lower its adaptive capacity is likely to be. As explained elsewhere in this dissertation, according to the IPCC (2007), poor communities can be especially vulnerable - particularly those concentrated in high-risk areas since they tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies (it is expected that climate change will affect farming, for instance, livestock production both directly and indirectly).

In assessing the dependence on natural resources, Vincent (*ibid*) observes that for some households, farming constitutes the main base of their livelihoods yet for others, it is an equal or lesser contributor alongside other economic activities but also that several households do not participate in farming at all. Rural farming/agriculture in most developing and less developed countries (especially in Africa) is very sensitive to environmental changes. When rains delay or fail for two consecutive seasons, a household that largely relies on farming would probably be worse hit than one that earns half of its living from non-farming activities like non-farm employment in the public service. As such, a higher share of agriculture in the

total income of a household may be deemed to bequeath the household in question with a higher susceptibility to environmental stress and therefore a lower adaptability. Interval scales have been used to pick up the relative **contribution of farming** to livelihoods of the various households and include the same as an indicator of susceptibility to environmental changes.

Source of cooking fuel is another useful indicator of the susceptibility to environmental changes. In much of the developing world (especially Africa), wood fuel whether in form of dry wood or charcoal, forms a major part of rural household energy supplies. This wood is in most cases obtained from the natural environment and therefore, it is appropriate to include it as an indicator for household reliance on natural resources. In the particular case of Kakamega District, Mwamba (2007) found out that over 97 per cent of the households used wood fuel for cooking (the bulk of it coming from the Kakamega Forest zone). The prevailing level of use of charcoal, kerosene, gas and other forms of energy in the area was demonstrative of the existing possibility (or lack of it) among households to switch to other forms of energy. A heavy reliance on firewood can be construed to imply a higher susceptibility to environmental stress and therefore a low level of adaptability.

An additional indicator of susceptibility to environmental changes is the **source of water**. Large rivers/lakes from which governments pipe water normally have their sources in diverse catchments. Local springs on the other hand tend to have less diverse catchments and can therefore be viewed as being prone to drying off in cases of localised environmental stress compared to large rivers. Because of this, a heavy reliance on local spring/stream water may be construed to imply a higher susceptibility to environmental stress and therefore a lower level of adaptability.

5. Housing Quality: The quality of people's houses/dwelling units can in some cases be the deciding factor when it comes to vulnerability to environmental stress/climate risks such as in the case of floods. Those living in mad huts may be expected to have far less adaptive capacity than those with brick houses. Grass thatched houses are not only dependant on the availability of thatch from the local vegetation (for regular maintenance) but are also more vulnerable to environmental forces (like strong winds, flooding and *El Nino*) than permanent houses.

Besides this, pieces of land with permanent houses can be used as collateral security in cases where households seek a bank loan (for example, to invest in a business). Semi-permanent and grass-thatched dwelling units are however not acceptable as collateral security to a majority of financial institutions. It can therefore be argued that, the more permanent (the better the quality of) the household head's house, the better the adaptability of that particular household is likely to be. The HACI therefore has a sub-index based on the quality of the household's **main housing/dwelling unit** (in most cases, the household head's house). It is however important to note here that people's houses or dwelling units in many developing countries are mostly built up and improved over time, as funds become available.

6. Awareness level and actions taken: As it were, most successful prevention of threats or treatments of ill conditions begin with accurate understanding or diagnosis or some sort of awareness about the problem. Social factors such as access to information, for example, can often aggravate local vulnerability particularly at times of heightened climate stress (O'Brien & Vogel, 2003). The households that are aware of natural resource depreciation or environmental/climatic changes can be expected to be relatively better placed to adjust to/prepare for/mitigate the same. Even more better placed are those households already taking some protective or adaptation actions such as on-farm growing of trees to adjust to declines in natural resources. These households are likely to be significantly different from the others which are unaware of the stresses around them or those doing nothing about the stresses. Households are bound to take actions depending on their awareness levels and those that can describe the prevalent environmental changes are presumably more aware of the same and therefore can adapt better than those that cannot describe any of the prevalent environmental changes.

In reaction to dwindling stocks of naturally growing vegetation useable for fuel, some households plant their own trees for domestic and commercial purposes to cover the shortage arising from dwindling natural vegetative cover and also for purposes of earning additional income. In such a case, it could be argued that, the more the number of trees planted by a household, the more prepared it is to mitigate against environmental stress (seen through soil degradation, erratic rainfall and reduced supplies of wood from environmental resources) and climatic changes (loss of income due to poor harvests). The presence and number of planted trees on household land could therefore serve to further underscore a household's commitment to enhancing its adaptive capacity.

Incorporating awareness and perceptions of environmental/climate change improves the HACI's suitability for inter-regional comparisons. For instance, it is important to know how such effects as crop losses associated with past extreme climatic events like droughts are viewed in different regions. According to Reid & Vogel (2006), farmers in Muden in South Africa saw these not as extraordinary and they (as well as the community) seemed to deal with them as they occur and take the necessary actions needed to move on. The two authors concluded that lack of information aggravated response options. For most systems and communities, changes in the mean conditions commonly fall within the coping range whereas many systems are particularly vulnerable to changes in the frequency and magnitude of extreme events or conditions outside the coping range (Smit *et al*., 2001). Smit *et al.* add that some research show that human beings have an impressive capacity to adapt to long-term mean climatic conditions but less success in adapting to extreme and to year-to-year variations in climatic conditions so that adaptations designed to address changed mean conditions may or may not be helpful in coping with the variability that is inherent in climate change.

7. Institutional and Infrastructural Environment: This is an additional albeit external sub-index incorporating factors that are beyond the influence of many ordinary households in rural areas but which have effects on their adaptability to environmental stress. Certain socio-economic and institutional constraints limit the capacity to respond. The vulnerability or security of any group is determined by resource availability and the entitlement of individuals and groups to call on these resources (Kelly & Adger, 2000). The extent to which individuals, groups or communities are 'entitled' to make use of resources determines the ability of that particular population to cope with or adapt to stress.

Merely assessing how individual households are interconnected with institutions may presume that the institutions are themselves in an optimal state even though sometimes they are hindrances and therefore contribute to a weaker adaptive capacity. Norms guiding patrilineal transfer of land from generation to generation in many African communities appear to weaken the adaptive capacity of many female headed households. In western Kenya, for instance, it has been common for in-laws to disinherit widows after the deaths of husbands. The household land (handed down through males) is often the first target and in case no male child is left behind, the brothers of the deceased man often snatch the land away from the

widow. The long process of securing a title deed and the costly succession battles in the court system is often beyond the reach of many poor households. Reid & Vogel, (2006), also espouse that ineffective institutional structures and processes limit household response options in the Muden area of South Africa.

Institutional and infrastructural environment therefore deserve to be incorporated in the HACI using appropriate indicators. The nearer a household is or the easier the accessibility to public offices dealing with such issues as administration, dispute resolution, disaster response and issuance of title deeds, the lower the cost of accessing public services and hence the higher the adaptability of such a household.
Given the high inequalities in income (resource) distribution often observed in many transition and developing economies, access to common property serves to partially cover certain needs of the less endowed sections of the populations. Households which can access common property can be said to be better provided for and therefore better capable of adapting than those with no access. For households engaging in production activities, the ease with which they can fairly exchange their physical produce (farm output, extracted raw materials or even produced furniture) for money or other commodities can significantly boost adaptive capacity. Therefore, the nearer a household is to a commodity exchange centre (market), the more easily it can exchange its commodities at a fair price (thereby avoiding pilferage and skipping a number of middlemen). In such cases, the fairer prices attracted for farm produce raise net household earnings and boost adaptation.

Related to this issue of access to markets, the further away from the access road a household is, the lower the chances that commodities would reach the market, that sudden illnesses would be attended to in time and that products required by the households would reach them at affordable prices. The exact type of access road also plays an important role so that being served by tarmac roads could be associated with a higher adaptive capacity while earth roads would be associated with lower adaptive capacity. Impassable muddy roads could delay delivery of products to markets thereby leading to loss of value (poor returns) and harming adaptive capacity.

In the face of environmental stress, better crop and livestock husbandry (improved practices) learned from agricultural extension officers possibly provide key avenues to boost adaptability. Visits by public agricultural extension officers could therefore be viewed as

creating a favourable institutional environment thereby boosting adaptability as do the efforts of the government in boosting adaptability through things like conservation, effective policy directions and awareness creation.

This chapter has presented recent research relating to the key issues of this dissertation namely: Climate change, environmental changes (with example from the prevailing situation in Kenya), vulnerability, adaptation and adaptive capacity. The chapter has also offered an explanation of how the assessment of adaptive capacity can be improved and elucidated the factors behind the improved household adaptive capacity index (HACI) put forward by this dissertation.

Since the HACI is a status quo assessment tool, gender of the household head (a factor which features in some household poverty assessment and welfare surveys exercises) has been excluded as a sub-index. However, nothing of significance to the exercise at hand has been lost due to this exclusion since the seven sub-indices are sufficient to pick up the actual adaptive capacity of a household (male or female headed) at any particular time. Differences between male headed and female headed households arising from patrilineal patterns of inheriting property would be adequately picked by such variables as economic value of household assets, rights to land, education level of household head and type of housing. In the final analysis, if female headed households have low incomes due to fewer resources or lower educational levels compared to male headed ones, then female headed households will feature significantly low adaptive capacity indices as compared to the male headed ones.

Finally, it is important to mention that socio-economic stressors occur on a continuous basis and that it is very difficult to separate the impacts of negative shocks related to environmental stress from those related to socio-eco-political and other factors. Furthermore, environmental stress and loss of biodiversity occurs simultaneous to climate change. Whereas the former has been documented in the area of study (see Lung & Schaab, 2004), there is a lack of adequate data to quantify the latter phenomenon in the area of study. However, experts are in agreement that climate change effects are already impacting household livelihoods in the whole of the East African region hence the description of the phenomenon in this dissertation.

In the next chapter the methodology and the frameworks of analysis are presented.

3.0 Study Design and Setting

The study behind this dissertation was organised into three broad parts based on research exercises carried out in a rural district in Kenya. The first part involved an assessment of the key sources of vulnerability faced by the rural households while the second part involved the assessment of adaptation and the development of a robust household adaptive capacity index (HACI) for use not only in hypothesis testing but also in assessing the levels of adaptability of individual rural households. In the third part, the study hypotheses were tested and the factors associated with high levels of adaptability identified using the assessment tool (HACI) from the second part of the study.

Field research exercises were planned and executed in Kakamega district of Kenya so as to:

- Advance understanding of vulnerability and adaptive capacity of the rural households to environmental stress as well as climate variability;
- Develop a robust household adaptive capacity index (HACI);
- Find out the key stages in the adaptation decision making process;
- Elucidate the adaptation efforts exhibited by the rural households in response to declines in natural resources and climatic changes; and
- Identify strategies and factors associated with higher household adaptive capacities.

The necessary field research was designed incorporating the issues at the core of this dissertation, that is, the assessment of vulnerability and adaptation (including adaptive capacity). It featured participant observation, focused discussions and the use of a structured questionnaire to gather data and information. Please see annex 3c and 4 for a detailed description of the method used in collecting and analysing data as well as the questionnaire.

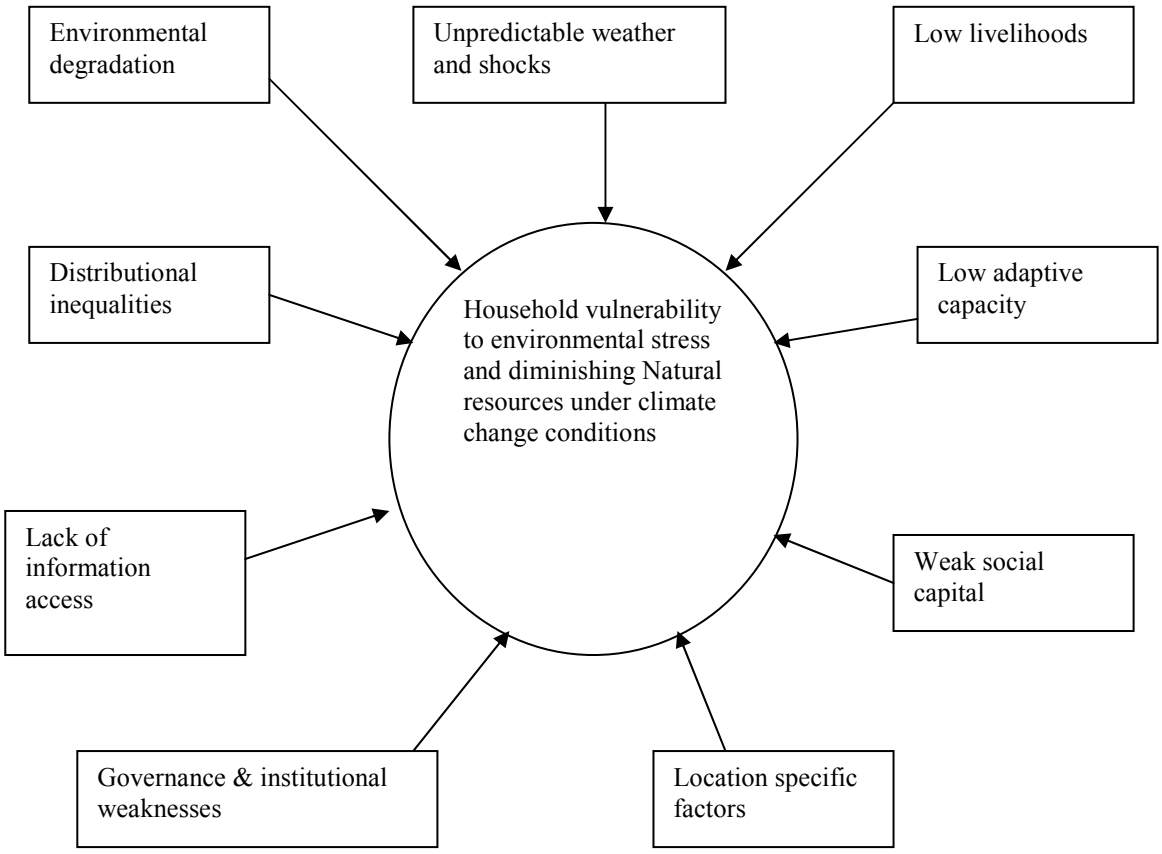
Part I: Understanding Vulnerability to Environmental Stress in Kakamega District

This part involved finding out the sources, drivers and extent of vulnerability to environmental and climatic changes. The framework used in assessing and understanding vulnerability is presented in figure 5. The studying of vulnerability was more of a status quo assessment rather than measurement. The study sought to find out which key elements occasion vulnerability, how vulnerability has evolved over time and whether or not the rural residents factor in sustainability in deciding land use, production methods and livelihood strategies so as to reduce future vulnerability.

Data was collected aimed at supplying empirical evidence to confirm or disprove the causes and drivers (identified from available literature) of vulnerability among households and identify any other location specific ones. Among the drivers and causes found in existing literature were:

1. Low levels of livelihood
2. Low adaptive capacity – (proxy; implementation of an adaptive capacity enhancing action)
3. Lack of access to information
4. Weak social capital; and external ones such as:
5. Degradation of the environment (soil degradation)
6. Unpredictable weather patterns and shocks such as droughts and floods
7. Weak institutional organisation and poor governance
8. Inequality in the distribution of resources and opportunities (social injustice)
9. Other location specific factors

Figure 5: Framework for Assessing Household Vulnerability



Source: Researcher's Conceptualisation following literature review

Part II: Assessing Adaptation - Developing a HACI

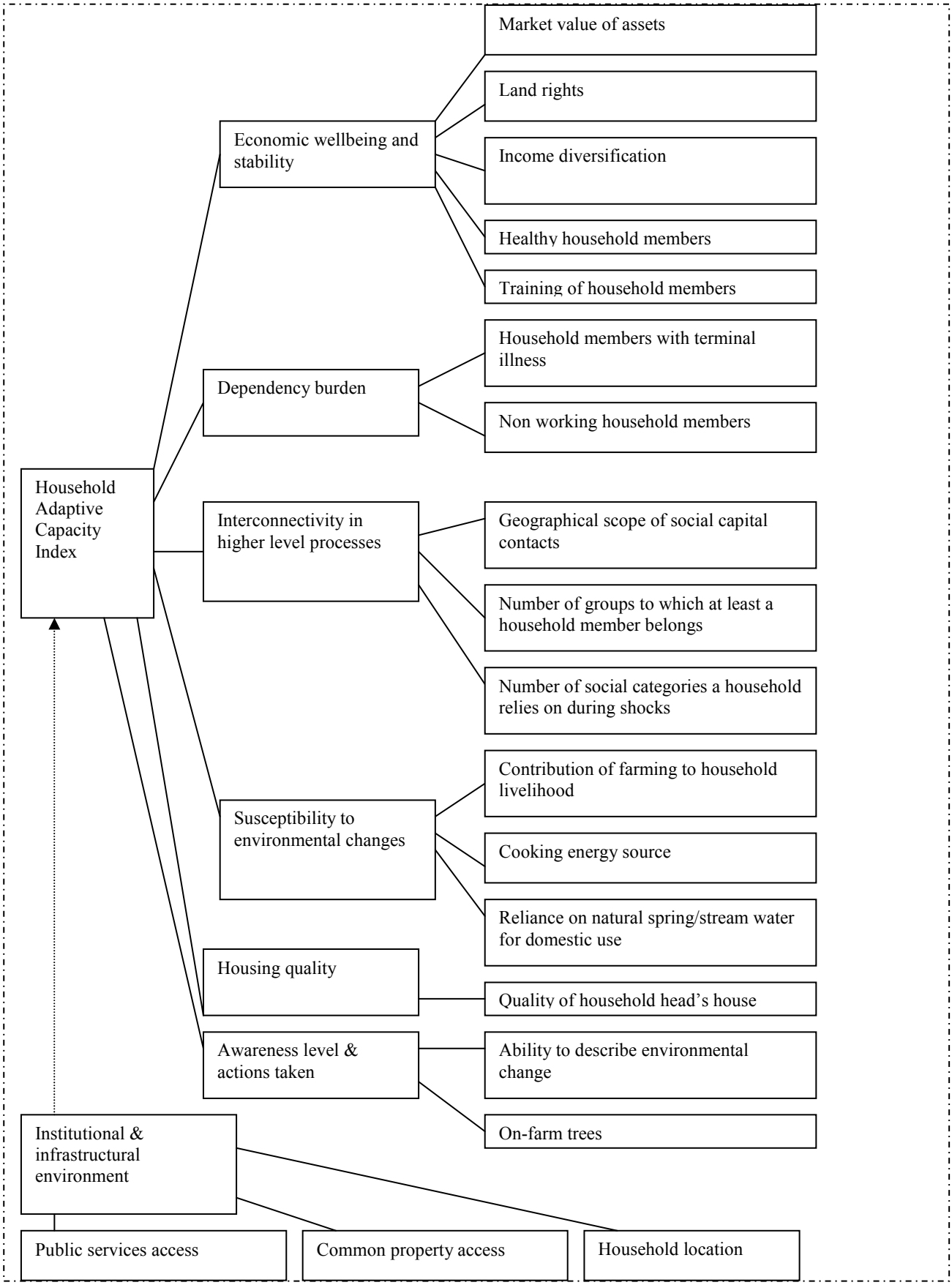
Having undertaken the necessary literature review, sought expert advice and inspected the available empirical evidence a framework for the HACI was developed. Indicators were then defined for the synthesized sub-indices of the household adaptive capacity index. In summary, the list of sub-indices identified for the HACI following literature review, expert judgement and assessment of the empirical evidence from research in the area of study is as follows (also illustrated in figure 6):

1. Economic Wellbeing & Stability
2. Dependency Burden
3. Interconnectivity in Higher Level Processes
4. Susceptibility to environmental changes
5. Housing Quality
6. Awareness level and actions taken
7. Institutional & infrastructural environment (additional/external sub-index)

Quantifying the Sub-indices of the HACI and the Associated Indicators

Armed with findings from previous research and the initial assessment of the data obtained from the field research designed for this dissertation, data was analysed using the framework presented in figure 6. As already presented, the HACI was built from six main (internal) sub-indices which were in turn built by a number of variables. In figure 6, the sub-indices are located in the middle column while their respective variables are presented on the right column. After the graphical summary of the HACI and its indicators in figure 6, a detailed explanation of the measurement (quantification) of the sub-indices by use of the indicators (variables) follows while a tabular summary of the quantification process is presented in tables 4 (a) and (b).

Figure 6: Structure of the HACI



Source: Author's Research

I. Economic wellbeing and stability

The economic situation of a household created by the tangible and intangible assets or resources at its disposal is a key sub-index with a positive relationship to the HACI since it determines whether the household can access solutions from the market to deal with challenges or not. The stronger or the more stable a household's economic situation is, the higher its adaptive capacity index is likely to be. The variables and measurement processes of this sub-index are described below (written documents are rare among rural households):

a) Market value (in local currency – KES[19]) of moveable and non-moveable assets (such as livestock, land, real estate, capital goods such as generators, oxen ploughs, sewing machines, power saws, motor cycles, bicycles, flour mills; and some of the durable household goods like television sets, sofa sets, gas cookers, cell phones, radios, solar panels among others). When negative shocks strike, households dispose these assets in order of reducing values and permanence so as to obtain money to deal with such shocks. Holding other factors constant, the higher the market value of assets held by a household, the better its economic wellbeing and stability is likely to be.

As may be seen in table 4a, the total value of household assets have been tied to a scale of points such that values below KES 150,000 would make a contribution of 1 point to the sub-index, values between KES 150,000 – KES 249,999 would yield 2 points, those between KES 250,000 – KES 349,999 would yield 3 points, those between KES 350,000 – KES 449,999 would yield 4 points while total asset values beyond KES 450,000 would contribute 5 points. A household whose assets are valued at KES 400,000 would have a contribution of 4 points to the sub-index (household wellbeing and stability) which in turn contributes to the overall HACI. By contrast, a second household with total assets valued at KES 200,000 would have a contribution of 2 points to the sub-index (household economic wellbeing and stability).

b) Land Rights

For a majority of rural households in developing countries, title deeds have continued to be a key form of collateral security for credit. Households with land title deeds can therefore be said to have better chances for personal credit as and when they may need it, say for investment in small businesses. The possession of title deeds therefore contributes to the

[19] Currency conversion during the survey period: €1 ≡ KES 100, $1 ≡ KES 75

stability of a household's economic situation which in turn enhances its adaptive capacity. Households with land but no title deeds may not quickly dispose the land or use it as collateral security for a bank loan. Therein lays the significance of title deeds. According to GoK (2005b), the high and rapidly growing population in Kakamega district drives the growth in poverty by abetting sub-division of land into uneconomical sizes with Lurambi and Ikolomani divisions being the worst hit areas. During a previous research by the author in Kakamega district (Mwamba, 2007) it was in deed observed that many households held very small acreages for which they had no title deeds. With no meaningful land holding or no title deeds, access to credit became greatly hindered yet GoK (2005b) identified low access to credit as a factor that hindered entrepreneurship in Kakamega district.

With reference to table 4a, possession of title deed would make a contribution of 2 points to the sub-index (household wellbeing and stability), possession of rights to communal (clan) land would bring forth 1 point while the absence of rights to land would make no contribution to the sub-index (household wellbeing and stability).

c) Income diversification

The more diverse the income sources of a household, the more stable its economic situation is bound to be c*eteris paribus*. In case one source yields below expectation for one reason or another, a cushioning effect could be obtained from the other sources. According to contemporary literature, income-diversification curve has been observed to be U-shaped (with poor households diversifying more, middle income earners diversifying less and high income earners also diversifying more). Even though income diversification is also likely to be related to the level of education, there is need to handle the two variables separately. Moreover, previous research in the area of study indicates that the level of education of the household head only has a significant effect on household income and livelihood in the cases of secondary school and above levels (Lay & Michuki, 2006[20]) yet a great majority of household heads in the sample had not attained this critical level of education. These observations moderate any differences that may arise due to the education level of the household head who is often the leader in decision making.

[20] Jahn Lay & George Michuki, 2006. A presentation to Stakeholders at Kakamega town.

In quantifying this variable, a value of 1 was has been assigned in cases with only one significant source of income, 2 for two significant sources of income, 3 for three significant income sources and 4 in cases with four or more sources of income.

d) Health of household members

A household made up largely of healthy members is likely to have a stable economic wellbeing compared to another one, most of whose members are sickly and therefore cannot properly engage in gainful economic activities. To quantify this variable and measure its contribution to the sub-index (household wellbeing and stability), a value of 3 has been assigned in cases of households with 100 per cent healthy members (wholly fit to work), 2 has been assigned in cases of households with over 75 per cent healthy members, 1 in cases of households with 50 – 75 per cent healthy members while 0 (zero) has been allocated in cases where no member is healthy enough to work as is likely to appear in some solo (one-person) households.

The maximum contribution of 3 points to the sub-index (household economic wellbeing and stability) achieved in cases where all household members are healthy to work for the betterment or maintenance of the household situation is comparable to a condition of optimal fitness.

e) Training of household members

The number of household members with secondary-school-and-above level of education as a proportion of the total number of household members has been used as an indicator for the level of human resource development within the household. In Kenya, as in many countries, significant impact on household wellbeing due to training is seen in cases of tertiary training. Since tertiary training often has secondary school certificate as a prerequisite, this choice of indicator is fair.

Other factors held constant, households with better training are more likely to be economically better off than those featuring low levels of training. It can therefore be argued that the higher the proportion of household members who had completed secondary school, the better the state of training within the household is likely to be. Households with better trained members are likely to better adapt to environmental stress. This variable is particularly important for Kakamega district where, GoK (2005b) reported a primary school drop-out rate

of 24 per cent and a secondary school drop-out rate of 5.3 per cent by 2002 (nevertheless, the school subsidy program introduced after 2003 may have slightly improved this situation). However, it is worth mentioning that some primary school leavers and secondary school drop-outs also obtain training in areas like welding, carpentry and tailoring via local polytechnics and apprenticeship thereby gaining entry into the market as artisans. This group of people have been provided for in the scaling system used.

The variable - household training - assumes a value of 1 where no household member has attained a secondary-school-complete and above level of education, 2 in cases where less than 25 per cent of the household members has attained the mentioned level, 3 in cases where 26 – 50 per cent of the members has attained the level, 4 in cases where 51 – 75 per cent of the members has attained the mentioned level and 5 in cases where more than 76 per cent of the household members has attained the mentioned level of education. A contribution of 5 points is therefore the absolute maximum input this variable may make to the household economic wellbeing and stability sub-index while one is the least possible.

Aggregating the contributions in terms of points made by the above described five variables (monetary value of assets, title to land, income diversification, number of healthy members, and level of training of members) of the household economic wellbeing and stability sub-index, one obtains individual values of the sub-index.

II. Dependency Burden

This sub-index has a negative contribution to the HACI since some part of the earnings of working household members have to be used to support the non-working and/or terminally ill ones thereby precipitating low marginal propensities to save (MPS) and low marginal propensity to invest (MPI). With little to spare, any efforts towards the boosting of the household's adaptive capacity via investment are likely to be weaker. Two variables have been chosen to capture the negative impact of dependency burden on the HACI. These are:

a) Incidence of terminal illnesses such as diabetes, cancer, tuberculosis and HIV/AIDS which not only occasion substantial expenditure on health care but also hinder patients' engagement in productive activities thereby making them dependant on other household members. A high incidence of long term and recurrent illnesses raises dependency and therefore leads to a low HACI. As a matter of fact, GoK (2005b) reported that the heavy impact of diseases like

HIV/AIDS, malaria and tuberculosis were eroding people's productivity in Kakamega district. The number of household members suffering from terminal illnesses has been used as one of the variables for the sub-index of dependency burden. The scale applied had the values: 0 (zero) in cases where none of the household members had a terminal illness, -1 (negative one) in cases where one member had a terminal illness and -2 (negative two) in cases where the number of terminally ill members was two or more.

b) Number of non-working household members

Households with a high number of non-working household members (high level of dependency burden) are often characterised by higher marginal propensities to consume (MPC) and are therefore less capable of saving for emergency let alone investment. Conversely, the higher the number of working household members, the lighter the dependency burden since it is shouldered by many. A lower number of non-working members is therefore favourable to adaptive capacity. According to the Kakamega district development plan (GoK, 2005b), the population of those aged 0 - 4 years accounted for about 20 per cent of the population and the dependency ratio in the district was 100:108 in 2002. For this variable, a value of 0 (zero) was assigned in cases of no dependants, -1 (negative one) was assigned in cases where the number of dependants was positive but less than 3 adult equivalents while -2 (negative two) was assigned in cases of numbers of dependants between 3 – 6 adult equivalents.

For the purposes of this research, household dependency burden captures the number of non-working persons (in form of adult equivalents) who rely on the support of the working household members. It takes into account the deepening effect of terminal illnesses on the overall burden. Two households with the same number of dependants may display quite different adaptive capacities if one of them has members with terminal diseases such as diabetes, cancer, tuberculosis or HIV/AIDS. During previous research by the author in the area of study, it was observed that ill-health constitute significant sources of negative shocks given that a very great majority of the population lacks formal health insurance.

Taking into consideration the scales applied to its two variables, this composite sub-index (household dependency burden) assumes -4 (negative 4) in its worst impact (absolute minimum) on the HACI while a sub-index value of 0 (zero) is consistent with an insignificant level of negative impact (absolute maximum), if at all, on the HACI.

III. Interconnectivity in higher level processes

This sub-index entails elements of social capital and networking that are helpful to households and which could therefore enhance adaptive capacity. This sub-index, whose variables are presented below, has a positive relationship with the HACI.

a) Geographical scope of social capital contacts

As already explained in chapter 2, persons within the same geographical region are more likely to be equally affected by the environmental stress prevalent within the given locality. Therefore, in case of localised environmental stress problems, contacts in far geographical areas which are less affected by such problems are the ones who may be better capable of assisting (with resources or logistics[21] for instance). Furthermore, rural households networking with persons located in urban centres (near public and commercial services) tend to have easier access to services and enjoy certain advantages not available to households without such contacts.

From their urban contacts, such households are better placed to secure temporary accommodation for household members who emigrate to urban centres in search of better economic opportunities or those who travel to follow-up on pension payments or even seek treatment from the few referral hospitals. Due to this, the more the number of contacts a household has in urban areas and other areas (located at least 50 km) away from the household in question, the higher the level of interconnectivity and hence the higher the adaptability of the household in question. A value of 0 (zero) was assigned in case of a household with no contact outside its locality, 1 was assigned in case of 1 – 2 contacts while 2 was assigned in cases of three or more contacts.

b) Number of Groups to which at least a household member belongs

Membership to groups has been observed to offer certain benefits (for instance, moral support, soft loans and information). The more the numbers of groups (including social networking groups, church groups and merry-go-rounds) to which household members belong, the better the household's interconnectivity and hence the higher its adaptability is

[21] A recent example but from a different kind of problem is the 2007/2008 post-election violence following a bungled election in Kenya. With shops and banks closed in violence hotspots and crucial goods and services unavailable, contacts located in less affected areas sent airtime and money to mobile phones of friends and relatives in affected parts of the country.

likely to be. The scale applied for this variable has the values: 1 for less than two groups, 2 for 2 – 4 groups, 3 for 5 – 7 groups and 4 in cases of more than seven groups.

c) Number of social categories a household relies on during shocks (level of diversification in social capital contacts)

The diversity of social groups (for instance, family, neighbours, church/group members, friends, acquaintances and employers) on which households can rely in cases of emergency is an important factor to consider when assessing its interconnectivity. A household which can only rely on its family (for instance, an uncle) but neither on friends nor employer may have nowhere to turn to when a negative shock affects the entire family rendering the usual contact incapable of assisting at that particular point in time.

Violence and epidemics like cholera are examples of negative shocks that frequently affect multiple family members precipitating a situation in which none can assist the other because almost all family members are equally affected. In such a scenario, a household which maintains contact with more social groups is likely to be better off. The higher the number of (different) social categories a household can rely on during shocks, the better the interconnectivity of such a household (hence the higher its adaptive capacity). The scale applied for this variable features: 1 in cases of households only relying on family, 2 in cases of households relying on neighbours in addition to family, 3 for three social groups, 4 in cases of four social groups and 5 in cases of five or more social groups (other social groups include co-operative society, self-help groups, church, work place and political party).

Given the above described three variables of interconnectivity (geographical scope of contacts, number of groups to which household members belong and level of diversification in social capital contacts), the absolute maximum number of points from this sub-index is 11 (consistent with the highest possible enhancing effect on the HACI) while the absolute minimum value is 2 (consistent with the least possible enhancing effect of this sub-index on the HACI).

IV. Susceptibility to environmental stress and climate variations

Depending on economic activities as well as energy and water sources some households are more susceptible to negative effects of environmental stress and climate variations than others. With increasing variability in rainfall, heavy reliance (95 per cent) on agricultural

income, for instance, portends a higher susceptibility than a low level of reliance on agricultural production (for instance, 20 per cent). This sub-index has a negative impact on the HACI. The applicable variables and their respective measurement scales are as follows:

a) Contribution of Farming to Household Wellbeing

Rain-fed economic activities are sensitive to environmental changes. When rains delay or fail for two consecutive seasons, a household that largely relies on farming may probably be worst hit than one that earns half of its income from non-farming activities like formal employment in the public service. For this reason, a higher share of agricultural income as a percentage of the total income of a household is likely to occasion a higher susceptibility to environmental stress and therefore a lower adaptive capacity. For this variable, a value of -1 (negative one) was assigned in cases where a household obtained not more than 35 per cent of its income from farming, -2 (negative two) was assigned in cases where income from farming accounted for between 35 – 70 per cent while -3 (negative three) was assigned where the share of income from farming activities was more than 70 per cent.

b) Cooking Energy source

The source of fuel for cooking within the household has been used as an additional variable to help capture household reliance on resources which are affected by environmental and climatic changes. A heavy reliance on firewood given the widespread depletion of natural vegetation in the area is construed to imply a higher susceptibility to environmental stress and therefore a low level of adaptive capacity. Stressed environments are often characterised by dwindling supplies of environmental/natural resource commodities including wood fuel. Given that most rural households in developing countries use wood fuel to some degree, the values attached to this variable were: -1 (negative one) in cases where households used wood fuel besides cooking gas or electricity, -2 (negative two) in cases of wood fuel (including charcoal) and kerosene, while -3 (negative three) was assigned where households used wood fuel exclusively.

c) Level of reliance on local spring/stream water for domestic use

In stressed environments such as those characterised by deforestation, eroded soils and erratic rainfall patterns, water stress is often precipitated with springs and streams suffering reduced volumes. Local springs tend to have less diverse catchments and can therefore be viewed as being more prone to drying off in cases of localised environmental stress compared to large

rivers or lakes. On the other hand, large rivers or lakes from which public water is normally drawn often have their sources in diverse catchments. For this reason reliance on spring/stream water is consistent with a higher susceptibility to environmental stress and therefore a lower level of adaptive capacity. A value of -1 (negative one) has been assigned to this variable in cases of households obtaining water from local springs while 0 (zero) has been assigned in cases of households with access to piped water.

Taking the extreme values from the three component variables (contribution of farming to household wellbeing, source of cooking energy and source of water for domestic use), the absolute maximum value of this sub-index (susceptibility to environmental stress) is -2 (least possible negative contribution to the HACI) while the absolute minimum is -7 (highest possible negative contribution to the HACI).

V. Housing quality

The quality of the main dwelling unit of the household is a sub-index of the HACI since in cases of extreme environmental, weather or climatic changes, for instance, flooding and strong winds, it can be the deciding factor as to what extent, a household is left distraught. Permanent houses are more durable and resistant to the vagaries of nature, are associated with less frequent repair needs and can be used as collateral in cases where households need bank loans. Mud-walled and grass-thatched dwelling units on the other hand are prone to destruction by strong winds, strong rains or floods as is often experienced in deforested landscapes lacking the soil-erosion-control and wind-breaker roles of trees. Grass thatched huts are also dependant on the availability of thatch from the local vegetation. Despite being less robust, mud-walled and grass-thatched dwelling units are important since they shelter households from the extremes of weather. This sub-index therefore has a generally positive relationship with the HACI.

The quality of the household head's house has been used as an indicator for the general housing situation of household because even though some households in the area of study had multiple dwelling units, households gave major focus in developing the household head's house. The measurement scale applied features the following values: A value of 1 for grass-thatched and mud-walled dwelling units, 2 for mud- or iron sheet-walled and iron sheet-roofed dwelling units, 3 for semi-permanent units (cemented floor, mud+cement walled, and

iron sheet-roofed) and 4 for permanent ones (cemented floor with brick/concrete/stone wall and iron sheet/tiled roof).

The more permanent the household head's house is, the better the adaptive capacity of that particular household. Consistent with the above described measurement scale for the indicator, this sub-index has values ranging from an absolute minimum of 1 (lowest possible positive contribution to the HACI) to an absolute maximum value of 4 (highest possible positive contribution to the HACI).

VI. Awareness level & actions taken

The level of awareness of environmental changes and climate variation is important for the ability of households to respond to the prevalent or impending changes. A household which is aware of the changes happening around it and/or has information on strategies for adaptation is expected to have a higher adaptive capacity compared to another which is oblivious of prevalent changes and open options or one which is doing nothing against the environmental changes. This sub-index has a positive contribution to the HACI and its variables are:

a) Ability to describe environmental changes

As already indicated, to be able to adapt, a household has to be aware or have some idea of the (negative) changes occurring around it. Knowledge about the change phenomenon is crucial in deciding how to react to/mitigate such changes. It is hence argued that households that can describe the prevalent environmental changes are better placed to adapt than those that cannot describe any of the prevalent environmental changes. The scale applied to this variable has the values 0 (zero) for inability to describe prevalent environmental changes and 1 for ability to describe prevalent environmental changes.

b) On-farm trees

A significant number of rural households in many transition and developing economies continue to rely on trees for fuel, construction and timber among other uses. Felling of trees for fuel has been observed to worsen water (environmental) stress in a number of ecosystems. In reaction to dwindling stocks of naturally growing vegetation useable for fuel, some households plant their own trees for domestic and commercial purposes to cover the shortage arising from dwindling natural vegetative cover and also earn additional income. In rural areas, tree planting appears to be one of the most common ways of coping with environmental

stress issues like declining biomass, loss of biodiversity, soil erosion, scarcity of timber/wood and declining incomes. This makes tree planting useable as an indicator for actions taken against environmental changes by individual households. The more the number of trees planted by a household, the better prepared it is to mitigate environmental stress (with the associated reduced supplies of environmental resource goods). The scale applied to this variable features 0 (zero) for no trees planted, 1 for less than five trees, 2 for 5 – 10 trees and 3 for more than ten trees planted by a household in response to prevalent environmental changes.

With the scaling applied to the above described two component variables (ability to describe prevalent environmental changes and number of on-farm trees), the values of this sub-index (awareness level and actions taken) range from an absolute minimum of 0 to an absolute maximum value of 3, representing the lowest and highest possible positive contributions to the HACI respectively.

External/Additional Sub-index

There are certain factors that are beyond the influence of many ordinary households in rural areas but which have effects on their ability to adapt to environmental stress. These factors have been grouped under institutional and infrastructural environment under which the households operate.

VII. Institutional & Infrastructural Environment

Three main variables have been used to capture the institutional and infrastructural environment. These are:

a) Common Property Access

Households' access to communal resources like grazing lands influences their adaptive capacities. In situations of high inequalities in income (resource) distribution as is often observed in many transition and developing economies, access to common property serves to partially cover certain needs of less endowed sections of the populations. Resource-poor households which can access common property can be deemed to be better provided for and therefore better capable of adapting compared to similar ones without such access. For this variable, cases with access to common property have been assigned a value of 1 and those without any access to common property have been assigned a value of 0 (zero).

b) Access to public services

According to GoK (2005b), poor infrastructure hindered entrepreneurship and access to health services in Kakamega district. In situations of heightened environmental stress and climate variability, diversification or switching into enterprises is one of the strategies used by household members to cope (especially where few chances for meaningful employment exist). Factors hindering entrepreneurship and access to markets or useful public services are therefore likely to lower household adaptive capacity.

For this reason the variable - access to public services - was measured with the help of the following indicators (lower level variables):

i) Number of visits by agricultural extension officer within the last 5 years

In the face of environmental stress, information on better crop and livestock husbandry (improved practices) coming from agricultural extension officers possibly provide key avenues to boost adaptability. Visits by agricultural extension officers are therefore viewed as boosting adaptability. Values of 0 (zero) has been assigned in cases of no visits at all, 1 in cases of one or two visits in five years, 2 in cases of one visit a year, 3 in case of once a month, and 4 in case of weekly visits.

ii) Type of access road

Generally speaking, the poorer the access road the lower the chances that: Commodities will reach the market in the desired condition, that sudden illnesses will be attended to in time, and that products required by the households will reach them at ordinary retail prices (prices devoid of increased transportation expenses and high margins factored in by traders). Being served by tarmac roads was therefore viewed as strengthening adaptability while reliance on earth roads weakens the same. Values assigned to this variable are: -1 (negative one) in cases of earth roads, 0 (zero) in cases of murram roads and 1 in cases of tarmac (macadamised) roads.

iii) Government role in supporting/impeding adaptation actions

Here, issues such as insensitivity to challenges affecting the households, too much bureaucracy, too much restriction, unclear policy direction or inaccessibility have been handled as impediments - from the side of the government - which serve to hinder adaptability. On the other hand, awareness creation, visible serious efforts at tackling

challenges and financial assistance are some of the positive public efforts that boost the adaptive capacity of rural households. The important role of the government in boosting adaptability through conservation efforts and environmental protection policies, however weak, cannot be overlooked. For this variable cases of negative government actions have been assigned the value -1 (negative one) while reported cases of positive contribution or actions from the government have been assigned the value of 1.

c) Household location

The physical location of households relative to government offices, markets and access roads contribute to their adaptive capacity to the extent that places like markets and public offices constitute avenues to mitigating actions. Business licences, government loans, registration of persons, issuance of title deeds, sale of property as well as transport and communication are issues that can be greatly affected by the location of the households yet these issues are important for adaptation. The following indicators (lower level variables) were used for this variable (household location) which is a component of the sub-index of institutional and infrastructural environment:

i) Distance to divisional headquarters

Where governance structures are in place, the nearer a household is to public offices dealing with such issues as administration, dispute resolution, disaster response and issuance of title deeds, the higher the adaptive capacity of such a household is likely to be. In cases where the distance to divisional headquarters is greater than 10 km (a significant challenge given poor transportation conditions), a value of -1 (negative one) has been assigned to this variable, 5 – 10 km has been considered average and therefore assigned a value of 0 (zero) while a distance of less than 5 km has been considered to be significantly advantageous to adaptation hence assigned a value of 1.

ii) Distance to nearest market (where one could exchange property such as livestock)

The nearer a household is to a market, the more easily it can exchange its commodities at fairer prices (avoiding pilferage and skipping a number of middlemen). Incomes from such commodity exchanges boost the households' economic situation and therefore make such households better capable of adapting. The values assigned are: -1 (negative one) in cases where the distance to the nearest market is greater than 10 km (a fairly big challenge moving goods from farm to selling point), 5 – 10 km has been considered average and therefore

assigned a value of 0 (zero) while a distance of less than 5 km has been considered to be significantly advantageous to adaptation hence assigned a value of 1.

iii) Distance of a household from the nearest access road

The further the access road, the lower the chances that commodities will reach the market fast enough and in good quality, that sudden illnesses will be attended to in time, and that products required by the households will reach them at affordable prices. For this reason, location too far away from access roads is likely to be accompanied by lower adaptive capacity. In cases where households are located more than 200m away from nearest access road, a value of -2 (negative two) was assigned, a location of 150 – 200m away from the nearest access road had a value of -1 (negative one) assigned to this variable, a distance of 100 – 150m attracted a value of 0 (zero), 50 – < 100m attracted a value of 1 while a distance of below 50m from the nearest access road attracted a value of 2 for this lower level variable.

Aggregating the lower level variables mentioned above (numbered using roman numerals) yields values of the respective intermediate variable which in turn if aggregated, yield the points for the sub-index (institutional and infrastructural environment). The absolute minimum value of this external sub-index is -6 (biggest possible negative effect) while the absolute maximum is 11 (consistent with the biggest possible positive effect) on adaptability. Tables 4a and 4b in the following pages summarise the measurement scales of the just elucidated sub-indices, (intermediate) variables and lower level variables.

The author wishes to state that it is often very rare to obtain written documents from rural households in many African communities. For this reason, collection of data on income and expenditure requires a lot of creativity and objectiveness. The author asked questions on incomes, expenditure, farm out-put, prices of agricultural products and livestock as well as average prices of land and durable household goods. Cattle equivalent units were used for quantification while household income figures were counter-checked against household expenditure figures so as to obtain realistic values (one can only spend that which has been obtained from various sources). Despite all these efforts there are bound to be residual limitations which should be taken into consideration by all readers of this dissertation.

Table 4a: Measurement Scale Applied to Variables of the Sub-indices

Index (min., max. values)	**Sub-indices** (min., max. values)	**Variables** (min., max. values)	**Values. Labels**
HACI (-6,35)	Economic wellbeing & stability (2,19)	Market value of assets (1,5)	1. < 150, 000
			2. 150, 000 – < 250, 000
			3. 250, 000 - < 350, 000
			4. 350, 000 - < 450, 000
			5. 450, 000 and above
		Land rights (0,2)	0. No or well wishers' land
			1. Communal land
			2. Title deed
		Income diversification (1,4)	1. One income source
			2. Two income sources
			3. Three income sources
			4. Four or more income sources
		Healthy household members (0,3)	0. None healthy to work
			1. 50 – 75 % healthy to work
			2. 76 - <100 % healthy
			3. Absolutely all healthy
		Training of household members (1,5)	1. 0 %
			2. 1 – 25 %
			3. 26 – 50 %
			4. 51 – 75 %
			5. 76 – 100 %
	Dependency burden (-4,0)	Members with terminal illnesses (-2,0)	0. None
			-1. One
			-2. Two or more
		Non-working members (-2,0)	0. None
			-1. 1 - < 3
			-2. 3 - 6
	Interconnectivity in higher level processes (2,11)	Geographical scope of social capital contacts (0,2)	0. None
			1. 1 - 2
			2. 3 and above
		Number of groups to which at least a household member belongs (1,4)	1. < 2
			2. 2 - 4
			3. 5 - 7
			4. > 7
		Number of social categories a household relies on during shocks (1,5)	1. Family
			2. Family & neighbours
			3. Three social groups
			4. Four social groups
			5. Five or more social groups
	Susceptibility to environmental changes (-7,-2)	Farming contribution to wellbeing (-3,-1)	-1. Less than 35 %
			-2. 35 – 70 %
			-3. Over 70 %
		Cooking energy source (-3,-1)	-1. Wood fuel + gas/electric
			-2. Charcoal + Kerosene
			-3. Exclusively wood fuel
		Water source for domestic use (-1,0)	0. Piped water
			-1. Spring/stream water
	Housing quality (1,4)	Quality of HH head's house (1,4)	1. Mud-wall & grass thatch
			2. Mud/iron sheet wall & iron sheet roof
			3. Semi-permanent
			4. Permanent
	Awareness level & actions taken (0,4)	Ability to describe environmental change (0,1)	0. No
			1. Yes
		On-farm trees (0,3)	0. None
			1. < 5
			2. 5 - 10
			3. > 10

Table 4b: Measurement Scale Applied to Variables of the External Sub-Index

HACI	Institutional & infrastructural environment (-6,11)	Common property access (0,1)	Common property access (0,1)	0. No
				1. Yes
		Public services access (-2, 6)	Agric. officer visits (0,4)	0. Not at all
				1. 1 or 2 times in 5 years
				2. Once a year
				3. Once every month
				4. Weekly
			Access road type (-1,1)	-1. Earth
				0. Murram
				1. Tarmac
			Government role (-1,1)	-1. Negative effect
				1. Positive effect
		Household location (-4,4)	Distance to divisional headquarters (-1,1)	- 1. >10 km
				0. 5 – 10 km
				1. <5 km
			Distance to nearest market (-1,1)	- 1. >10 km
				0. 5 – 10 km
				1. <5 km
			Distance from access road (-2,2)	-2. > 200 m
				-1. 150 - < 200 m
				0. 100 – 150 m
				1. 50 - < 100 m
				2. 0 - < 50 m

Part III: Hypotheses testing and identification of factors associated with high adaptability

Having developed the HACI from part II, the next stage was the testing of the study hypotheses. The research hypotheses tested were:

H1: Regular and optimal farm input use positively influences HACI

H2: Micro credit positively influences the HACI

A closer look was also directed at effects of diversification into non-agricultural activities on the HACI

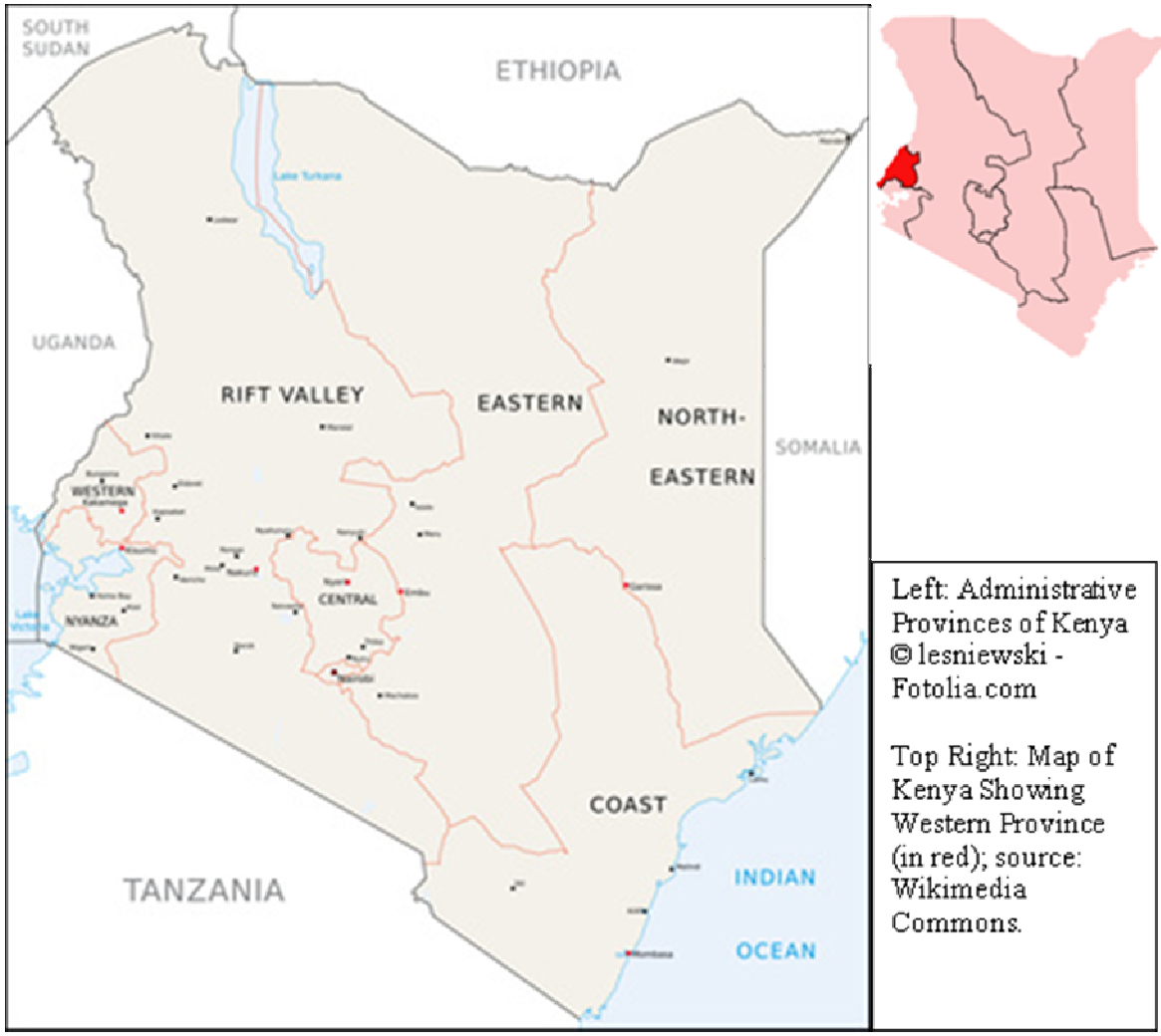
3.1 Study Area

The larger Kakamega District (before recent divisions) of Kenya was as at the time of the field research, a densely populated area inhabited by poor farming communities who drew many benefits from a biodiversity-rich remnant of a tropical rainforest located in the western part of Kenya. As a result, the survival of the forest - known as Kakamega forest – was under immense threat. GoK (2005b) reports that high population growth rate in face of limited resources, poor economic performance and the HIV/AIDS epidemic were leading factors behind high poverty levels in the district with the most vulnerable groups being the landless, female headed households, subsistence farmers, unemployed youths, street children, the

elderly and HIV/AIDS orphans. A significant number of residents relied on low-technology peasant farming as an occupation to maintain their households.

Administration: The larger Kakamega was one of the districts that made up the Western province of Kenya whose headquarter remains Kakamega town (also the district headquarters). The district had a total land area of approximately 1395 km^2 roughly located between longitudes 34°32”E and 35°57’30”E and latitudes 0°15” N and 0°07’30”N. The district bordered Butere/Mumias and Bungoma Districts to the West, Nandi District to the East, Vihiga District to the South and Lugari District to the North.

Figure 7: Maps of Kenya Showing Locations of Kakamega & Western Province



Left: Administrative Provinces of Kenya © lesniewski - Fotolia.com

Top Right: Map of Kenya Showing Western Province (in red); source: Wikimedia Commons.

The district was then sub-divided into seven administrative divisions. According to the 2002 – 2008 Kakamega district development plan, Kabras division measuring 424.2 km^2 and Municipality division measuring 49.9 km^2 were the largest and smallest of the seven

administrative divisions respectively. The other divisions were Shinyalu (332.6 km^2), Lurambi (194.1 km^2), Navakholo (173.4 km^2), Ikolomani (142.9 km^2) and Ileho (77.7 km^2). Each of the divisions was headed by a District Officer who reported directly to the District Commissioner. The divisions were in turn sub-divided into smaller units called locations. The district had 27 gazetted locations by the end of 2006. Each of the locations was headed by a chief while the smallest recognized administrative units in the district (as was the case in the whole of Kenya) were the sub-locations (of which, Kakamega district had 97). However, some changes have since occurred.

In 2007 and the subsequent period, Kakamega district was subdivided such that the area previously under one administrative district fell under four administrative districts by 2010. These were: Kakamega East with its seat at Shinyalu (incorporates Shinyalu division with its seat at Shinyalu and Ileho division with its seat at Kambiri), Kakamega South (has its seat in Malinya and covers Ikolomani division), Kakamega North (covering Malava division with district and divisional offices in Malava) and Kakamega Central (covering Municipality division with seat in Kakamega town, Lurambi division whose seat is at Lurambi and Navakholo division whose seat is at Navakholo). With regions and counties provided for in the recently (August 2010) adopted constitution of the republic of Kenya, the study area falls under the Kakamega county (population of 1,660,651 by 2009) in the Western province/region. Besides hosting the headquarters of Municipality division and Kakamega Central district, Kakamega town also remains the regional and county headquarter. However, at the time of compiling this dissertation, Kenya was still putting in place structures for the implementation of the new constitution and the future of the administrative positions under the provincial administration (traditionally appointed by the central government) such as those of the assistant chiefs, chiefs, district officers and commissioners was still unclear.

In terms of representation, local authorities in the district included Kakamega Municipal Council (with 13 wards), Kakamega County Council (with 13 wards) and Malava Town Council (with 4 wards) at the time of the survey for this dissertation. At the apex of the municipal council is an elected mayor while the town councils have elected chairpersons as heads. Town clerks are employed by the central government and are in charge of day to day running of the councils. The district had 37 electoral wards represented by elected councilors and four electoral constituencies (Ikolomani, Shinyalu, Malava and Lurambi) represented by

elected members in the Kenyan parliament.

People: Most of the inhabitants of the district are Bantu farmers of the Luhya ethnic group. Within this ethnic group are loose sub-groups united by a common language, culture and origin. The major sub-groups include: Maragoli, Bukusu, Kisa, Kabras, Marama, Watsotso, Isukha, Bunyore and Idaho. There are also traces of people from other cultural backgrounds like the Kalenjin, Kikuyu, Luo and Asians who have settled in the district due to work or who bought land and settled there. Population growth rate in the district has tended to decline over the past three decades. According to the 1999 Kenya Population and Housing Census, the district had a population of 603,422 people with an annual growth rate of 2.12 percent, a lower rate compared to one of 2.98 percent per annum in 1989. Possible explanations for this scenario include the negative impact of the HIV/AIDS pandemic and a reduced fertility rate thanks to the intensification of family planning campaigns. Table 5 presents a summary of the district's key demographic statistics in the recent past.

Table 5: Summary of Kakamega District's Demographic Statistics in 2002

Population	643,457
Number of Males	309, 409
Number of Females	333, 637
Female/Male Sex Ratio	100:93
Size of youthful population (15 – 25 years)	146,886
Primary School Population (6 – 13 years)	161,344
Secondary School Population (14 – 17 years)	67,639
Labour Force (15 – 64 years)	222,089
Dependency Ratio	100:108
Population Growth Rate	2.12%
Rural population in 2002	514,447
Urban Population in 2002	125,599
Proportion of Population below poverty line according to WMS 1994 (province = 51 %, nationwide = 47 %	52 %
Proportion of Population below poverty line according to WMS II of 1997	57.47 %

Source: Adapted from GoK (2005b)

The district was projected to have 730,373 people by the year 2008. Even though the finer details of the 2009 Kenya National Population and Housing census were still being processed as at the time of writing this dissertation, the recently released initial results of the 2009 census revealed that Western province under-which the study area falls, accounts for over 11 per cent (4,334,282 people) of Kenya's population (38,610,097 people). Just like the nationwide scenario, the district population structure features a young population, the bulk of which is aged 18 years and below. According to the Kakamega district development plan (GoK, 2005b), the population of those aged 0 - 4 years accounted for about 20 per cent of the

population while that of females in the 15 – 49 age bracket made up approximately 24 per cent of the whole population in 1999. This population structure and its implications were reflected in the dependency ratios (100:108) and, together, they impacted the rural household incomes, expenditure patterns and investment decisions in mixed ways.

The relatively expansive Kabras Division has had the highest population in Kakamega district thanks to the immigration of people from other divisions and other districts in search of arable land. Shinyalu Division has also tended to attract immigrants to engage in forest-related activities. Ileho (with poor physical infrastructure) and Navakholo divisions have been the relatively low populated divisions.

Table 6: Kakamega District's Socio-economic Indicators - 2002

Total number of Households	125,901
Average Households size	4.8
Number of female headed households	40,288
Number of children headed households	2,518
Number of disabled	60,342
Children needing special protection	3,258
Absolute Poverty (Rural & Urban) according to WMS II	57.47% (369,559)
Income from Agriculture	62%
Income from Rural Self employment	8%
Wage employment	20%
Urban self-employment	2%

Source: Adapted from GoK (2005b)

Natural Resources: At the time of the field research behind this dissertation, Kakamega forest was not only the most outstanding geographical feature in district but also a key tourist attraction site in Western Kenya given its wealth in biodiversity resources (especially plants, butterflies, monkeys and birds). With its diverse flora and fauna, the forest stretched over Shinyalu, Ileho, Kabras and Ikolomani divisions and yielded timber, fruits, honey, thatch and pasture for livestock among other commodities. The total value of charcoal, pasture, fuel wood, medicinal products, timber, pole wood and gold derived from the forest by the adjacent households was estimated at KES 345 million while the department of forests reported revenues of KES 12.9 million in 1992 (GoK, 1994) from extraction and user fees. Adjacent to the Kakamega forest is the Nandi escarpment that forms a prominent feature on the district's eastern border while River Yala also flows through some parts of the district.

The dominant soil types of the district are the dark-brown sandy loams and the dark-red volcanic soils. The district has an altitude ranging from 1,250 metres to 2000 metres above sea level. With the district's bimodal rainfall pattern, meaningful precipitation was experienced between March and July and between September and November annually for long and short rains respectively with the average annual rainfall ranging from 1,000mm per annum in the northern parts of the district to 2,400mm per annum in the southern parts. However, erratic rainfall was a growing concern in the first decade of the 21 century. The district's driest months have been December, January and February. The District has high temperatures all the year round slightly varying in mean with maximum and minimum ranges of 28°C to 32°C and 11°C to 13°C respectively.

Economy: The district is predominantly agricultural with a few industries - mostly agriculture based. Agriculture continues to be the mainstay of the district (share of over 62 per cent of household incomes in the district). Sugarcane, tea, coffee, maize, vegetables, bananas, cassava, beans, sweet potatoes and horticultural crops are the main crops grown in the area with cattle and poultry farming forming an important asset base for the rural households. The sale and consumption of livestock products such as meat, hides, skins and milk significantly contributes to household wellbeing (GoK, 2005). By the time of his dissertation, over 90 per cent of the population living in the rural areas depended directly or indirectly on farming while an estimated 75 per cent (482,285) of the rural population worked in the agricultural sector (GoK, *op cit*). Even as overall unemployment and underemployment remained high, GoK (2005b) reported that females made up 54 per cent of the total labour force in the district while males made up 46 per cent as at 2002.

In terms of industries, saw milling and sugar cane factories make a significant contribution with notable plants being Kabras Saw Millers, Sembi Saw Millers, Butali Sugar factory, a number of sugarcane jaggeries and a number of small-scale industries and enterprises. Agricultural activities continue to absorb the bulk of the labour force with casual employment peaking in planting and harvesting seasons. Some residents are also employed in the urban areas like Kakamega town and local trading centres like Shinyalu. With the ever declining size of household landholding, migration within and away from the area in search of employment has intensified over the last two decades. As a matter of fact, farming has been recording declining yields since 1991 partially due to the declining land sizes, rising cost of

farm inputs, unfavourable commodity markets leading to disillusionment, lack of affordable credit schemes, poor weather conditions and low rate of adoption of new technologies. With declining household landholding, finding pasture for livestock has also increasingly become difficult.

Trading activities involving agricultural produce and consumer goods has offered some residents an alternative income source with Kakamega town remaining the key trading centre. The town is linked to other smaller trading centres by Earth and Murram roads while the Kisumu- Kakamega – Webuye – Kitale and the Kakamega – Mumias – Busia tarmac roads connect the district to other key towns. There is also a small air strip within Kakamega Municipality. Postal services are available at the major urban areas in the district with bus companies offering mail and parcel delivery services.

The availability of infrastructure and social amenities to households in the district is directly related to distance to the nearest urban centre. Save for the major trading centres, most of the areas in the district are yet to be connected to the national electricity grid. With around 361 primary schools and approximately 87 secondary schools, educational institutions are relatively well distributed in the area while the Masinde Muliro University of Science and Technology (created through a charter in 2006) became the latest addition to the higher learning institutions in the district. However, school drop-out rates have been historically high. The district development plan (GoK, 2005b) identifies morbidity and mortality related to HIV/AIDS as a contributor (in addition to lack of money for educational expenses) to high rates of school drop out (and therefore poverty) in the district. Teenage pregnancy and early marriages also drove female students' school drop out rates (however, with the public subsidies in the educational sector since 2003, the situation is expected to have slightly improved).

Health and Nutrition: As at 2010, the availability of health care services and facilities was still very low. In 2002, the Doctor: Patient Ratio (DPR) in the district was estimated at 1: 14246. Access to safe and portable water for domestic use was also a key challenge in the district. With a total of 55 facilities (12 hospitals, 15 health centres, 20 dispensaries and 8 clinics), the greater Kakamega district had a fair number of health delivery points but key hindrances to improved health in the district have included low access to medical services by a majority of the people due to the relatively high costs, inadequate or poorly equipped health facilities,

staff shortage and lack of maintenance of the health facilities. The development plan (GoK, 2005b) further reports that the average distance to a health facility is 10 kilometres in rural areas and 500 metres in urban areas while the doctor patient ratio stood at 1: 14,246.

The most prevalent diseases in the district were identified to be Malaria, skin diseases, diarrhoeal and respiratory tract infections (RTI) with infant and child morbidity being high while infant mortality stood at 63.9 deaths per 1,000 live births by 1999 (see table 7). The HIV/AIDS prevalence rate in the district was 23.8 per cent (one of the highest rates in Kenya) while the bed occupancy rate was approximately 60 per cent of total admissions. The most affected groups were girls aged 15 – 19 and men aged 19 - 35 years. This high HIV infection rate led to an ever increasing number of orphans; decreased agricultural productivity; increased child prostitution and child labour; high dropout rate from schools; and increases in the numbers of child and elderly headed households. Other challenges in Kakamega include high maternal mortality and a high incidence of malnutrition.

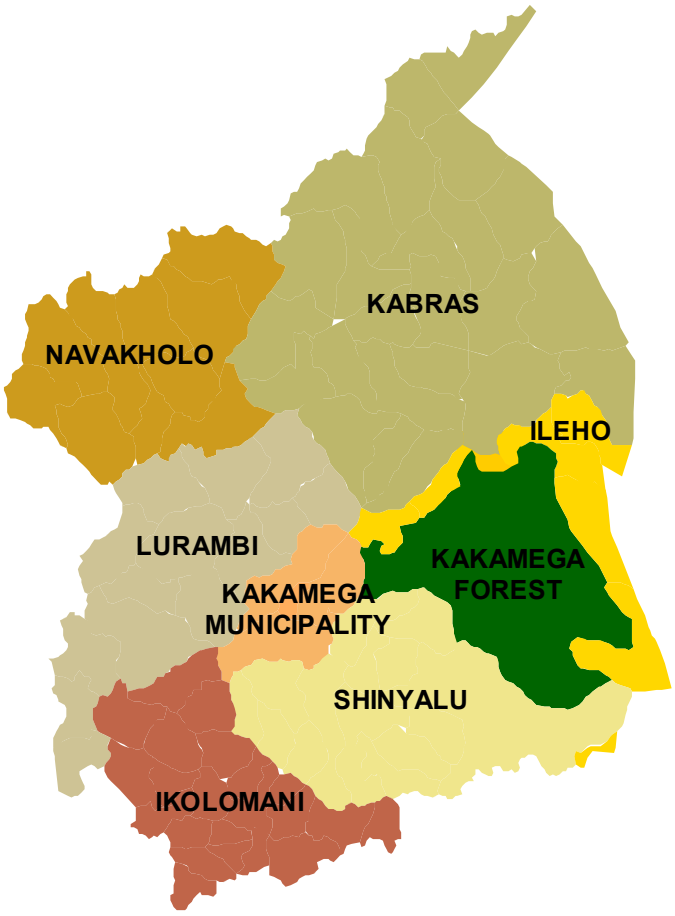
Table 7: Kakamega District Health Indicators

Crude Birth Rate (CBR)	34/1000
Crude Death Rate (CDR)	13/1000
Life Expectancy	53 years
Infant Mortality Rate (IMR)	63.9/1000
Under 5 Mortality Rate	122.5/1000
Total Fertility Rate	5.1
HIV Prevalence Rate	23.8%
Doctor/Patient Ratio	1:14,246

GoK (2005b) Kakamega District Development Plan 2005 - 2010

Reasons for choosing Kakamega as a study area: A number of factors made Kakamega District a suitable area for the research behind this dissertation. To begin with, the economic and demographic situation of district reflected that of Kenya and other Eastern Africa countries fairly well. According to the 2009 Kenya National Population and Housing Census, the mean population density for the district was estimated at 432 persons per square kilometre with this high population density exerting an increasing pressure on land thereby not only decimating average farm size per households but also making it very hard to retain fallow periods for land regeneration and thereby hastening soil degradation (environmental stress). This situation obtains in most rural parts of Kenya and the Eastern African region. Figure 8 presents the map of the larger Kakamega district and Kakamega forest.

Figure 8: Map of the old Kakamega District of Kenya Showing the Location of the Kakamega Forest



(*Source: BIOTA East Africa)*

Towards the mid of the first decade of the 21st century, immense pressure on Kakamega forest (whose position is shown in figure 8) led the government into tightening regulations on extraction of forest resources (see annexure for more information). This action further underscores the importance of the study area given the seriousness of environmental stress at the local level which makes the district a suitable candidate for the understanding of vulnerability and adaptability among rural households.

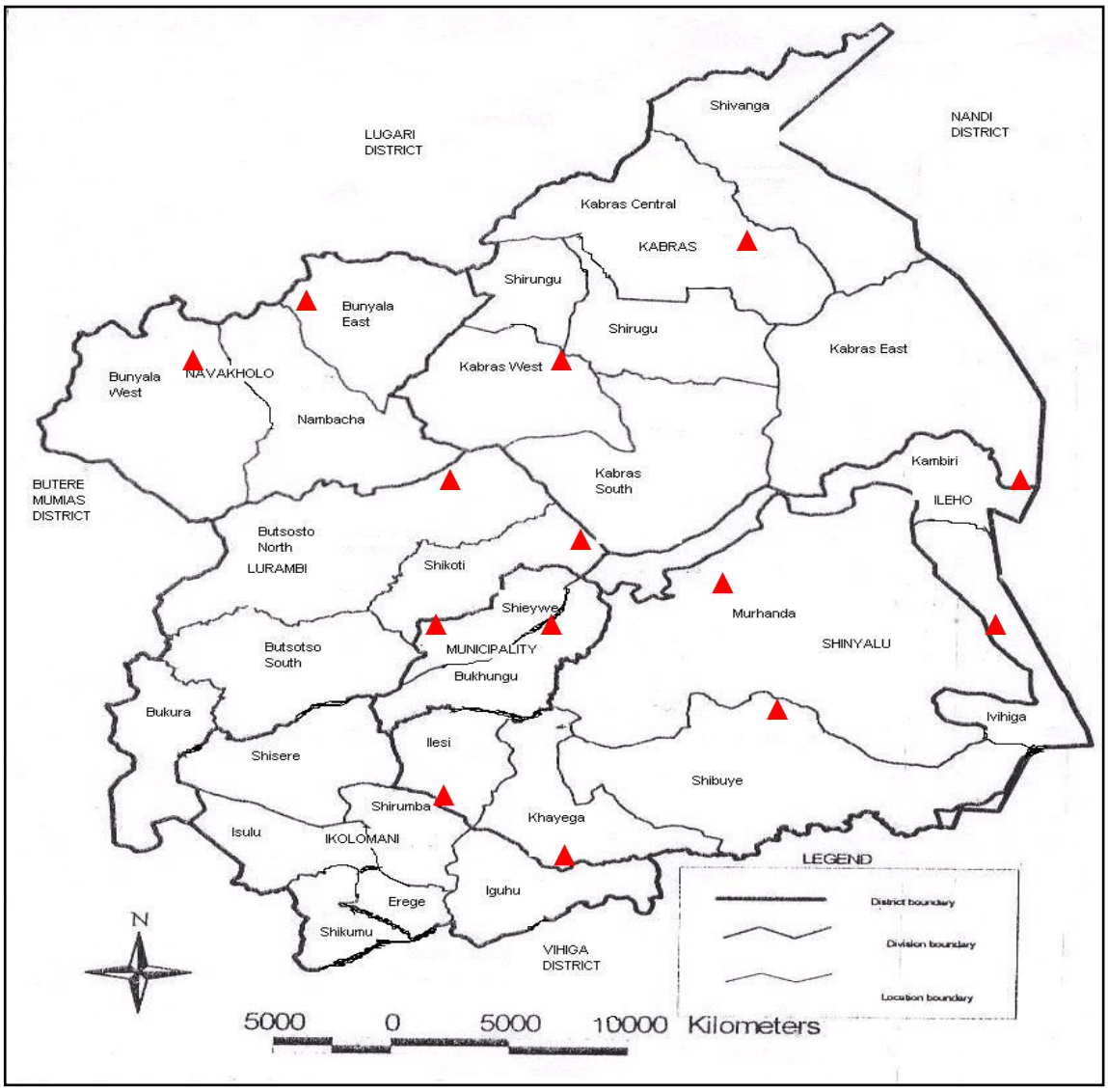
As a matter of fact, the field research behind this dissertation was undertaken within a larger research project which also had a focus on Kakamega forest - 'Anthropogenic risk factors and management of biodiversity for rural livelihoods around East African rain forests' (BIOTA E14c) - which was part of efforts by local and international actors directed towards the conservation of biodiversity resources. During previous research trips made by the author to

the area of study, it had been noted that environmental stress (including soil degradation, erratic rainfall and depletion of vegetation) and diseases were causing significant vulnerability to the rural households and this aroused an interest to better understand the prevalent situation.

3.2 Sampling and Data Collection

Sampling and data collection was done in the period between March and September 2009. Multi-stage random sampling (in Kakamega District) yielded a sample of 403 households.

Figure 9: Map of old Kakamega District Showing Administrative Divisions Before 2007



Source: Government of Kenya (2002). Kakamega District Development Plan 2002 – 2008. Nairobi: Government Printer. Note: ▲ Indicates the sampled locations where the interviews were carried out.

In each division (shown in figure 9), a list of locations was obtained from which two locations were randomly selected. From each of the selected locations a list of sub-locations was

obtained from which one sub-location was randomly selected. From each of the randomly selected sub-locations, a list of villages was obtained from which three villages were randomly selected and then the interviewers administered the questionnaires to every third rural household starting from the eastern to the western parts of the villages that had been selected without repetition.

Data collection for the three main parts of the study was done with the help of a single comprehensive questionnaire (in appendix) administered with the help of four research assistants understanding the local dialect.

4.0 Rural Households and their Environment

This section presents some of the results of the analysis of the data collected from the field. Some of the general descriptive statistics of the sample are presented followed by some key results related to vulnerability and adaptation (coping or mitigation strategies). However, focused presentation and discussion on the descriptive statistics of specific relevance to the HACI is to be found in chapter 5.0.

4.1 General Descriptive Statistics

In the area of study, 49.1 per cent of the sampled households exhibited nuclear family settings and 69.5 per cent of all the households in the sample consisted of six or less members (headcount) an observation which was fairly consistent with GoK (2005b) which reported an average household size of 5 persons. Mortality due to HIV/AIDS and the related increase in dependency levels was observed to be an important factor affecting household sizes. Regarding the level of education attained by the household head, most households were headed by persons who had not completed the secondary school level of education (also illustrated in the following pie chart – figure 10). This observation is important for the household wellbeing and stability sub-index of the HACI, for which the level of training in a household is a variable.

Almost 75 per cent of all the households had farming (agricultural activities) as the main occupation of the household head (pie chart illustration in figure 11). However, Ikolomani, Municipality, Lurambi and parts of Kabras divisions were relatively strongly represented in formal employment. These observations are not only important in the assessment of income diversification but also for susceptibility to environmental changes. It was also observed that a majority (72.7 per cent) of the households engaged mainly in food crop production with the mean land-holding being 1.6 acres (landholding is important for household wellbeing and stability). Even though 53.4 per cent were observed to be maintaining the use of traditional seed varieties at every planting season, it is noteworthy that households endeavoured to use improved seeds as much as their finances permitted – sometimes using both improved and local seeds in a single planting season. This is indicative of a high level of acceptance of and aspiration to use improved seeds.

Having had an overwhelmingly large share of rural households in the sample, it unsurprisingly turned out that 90.8 per cent of the sampled households relied on firewood as the chief source of energy for domestic use (basically cooking food) and 91.8 per cent relied on springs/streams for the supply of water for domestic purposes. In households near Kakamega town and some in Lurambi and Ikolomani divisions, significant use of kerosene and gas was observed. These are further observations related to the sub-index of household susceptibility to environmental changes.

Another observation, perhaps due to a scarcity of thatch coupled with the desire to construct more durable dwelling units, was that 73.5 per cent of the households had iron sheet-roofs on their main dwelling units (important for the sub-index of quality of household head's house) compared to 26.5 per cent that had grass thatched huts as their main dwelling units. Related to this, was the further observation that 24.1 per cent of the households had absolutely no grass thatched huts in their homesteads whereas 75.9 per cent had between 1 – 5 grass thatched huts being used for different purposes (not necessarily as main dwelling units/household heads' houses).

Fig. 10: Highest Level of Education Attained by Household Head

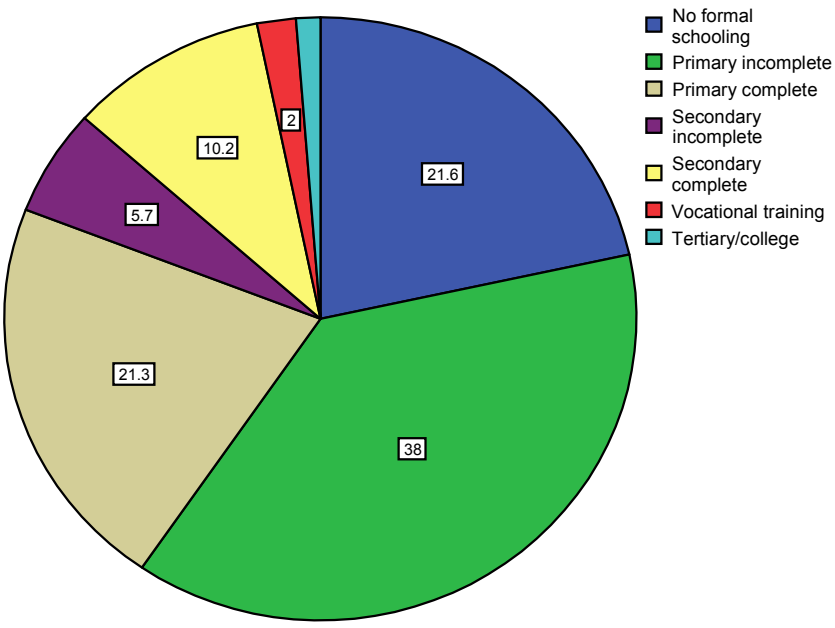
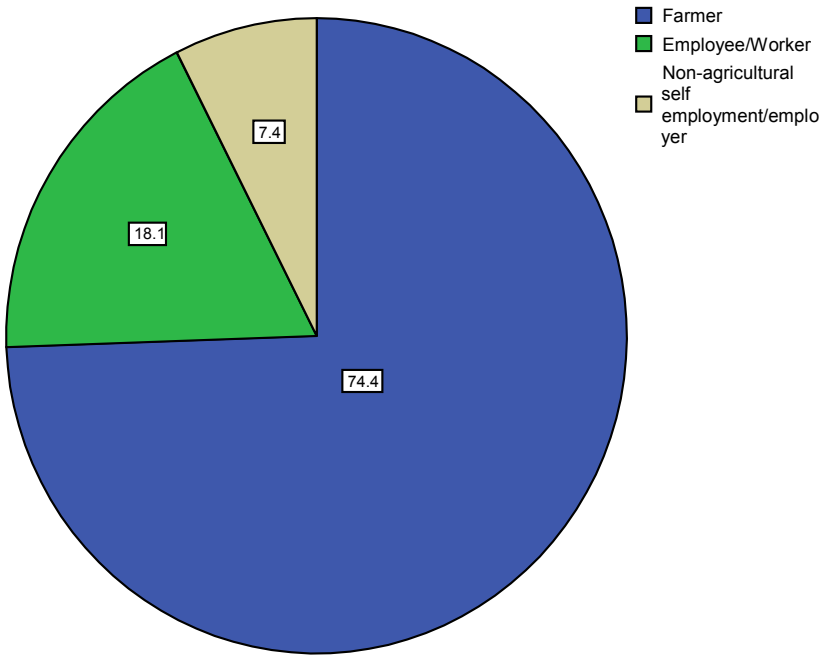


Fig. 11: Main Occupation of Household Head as Seen by Time Spent and Income Generated



More than half of the total value of household farm output was consumed within the households. Younger peasants tended to have relatively more surplus of farm output for the market while middle-aged and older household heads reported little if any surplus and even food deficits which were attributable to environmental stress, inadequate labour for the farm work (thanks to emigration and diversification into low-income non-farm activities like bicycle and motorcycle taxi) and higher dependency burdens among other things. Popular food crops included maize, beans, bananas and sweet potatoes. Beans performed particularly very poorly in Ikuywa in Ileho division and in Shinyalu division, a problem the farmers in the two divisions blamed on poor soils and hailstones respectively. Small holder cash crop farms of tea and coffee were observed particularly in Shinyalu and Municipality divisions while sugarcane farming featured prominently in Kabras division.

In terms of engagement in non-agricultural enterprises (an issue of importance to income diversification which is a variable for the household wellbeing and stability sub-index), 59.8 per cent of the households interviewed reported engagements in businesses with diverse levels of profitability (shown in table 8) with illicit alcohol (13.2 per cent), transport (9.9 per cent),

furniture & wood related (5.5 per cent) and food production (5.2 per cent) being the four leading types of business. Unfortunately, 75.6 per cent of those engaged in non-agricultural enterprises reported reducing or stagnating rates of profitability over the three years preceding the survey.

Table 8: Statistics for Average Household Net Monthly profit from Non-agricultural Enterprise

N	Valid	214
	Missing	189
Mean		3690.2804
Std. Error of Mean		251.83981
Median		2500.0000
Mode		5000.00
Std. Deviation		3684.09880
Range		28910.00
Minimum		90.00
Maximum		29000.00
Sum		789720.00
Percentiles	25	1200.0000
	50	2500.0000
	75	5000.0000

In terms of household assets, land, bicycles, livestock, radios and cell phones of diverse monetary values were the items that featured in most households. The total monetary value of such assets influence the household economic wellbeing and stability sub-index. These assets would be sold or pledged in times of negative shocks so as to bridge deficits. Table 9 presents the statistics of the monetary value of assets held by the households.

Table 9: Statistics for Total Monetary Value of Moveable and Non-moveable Assets Owned by Households

N	Valid	403
	Missing	0
Mean		216203.7965
Std. Error of Mean		12063.39823
Median		180100.0000
Mode		162500.00
Range		3230700.00
Minimum		2500.00
Maximum		3233200.00
Sum		87130130.00
Percentiles	25	111500.0000
	50	180100.0000
	75	240900.0000

As may be seen in table 9, the range of the total monetary value of moveable and non-moveable assets is quite large and this is consistent with the prevalent inequalities in the distribution of resources. Annual incomes and expenditures also greatly varied between the households (thanks partially to the already mentioned unequal distribution of resources in the area, as is also the case in the whole country). As can be seen in table 10, annual expenditures among these rural households ranged from KES 5,700 to KES 606,528.

Table 10: Annual Expenditure on Food and Non-Food Items[22]

N	Valid	403
	Missing	0
Mean		85454.7990
Std. Error of Mean		2958.62866
Median		70680.0000
Mode		63600.00(a)
Std. Deviation		59394.05585
Variance		3527653870.057
Skewness		2.948
Std. Error of Skewness		.122
Kurtosis		16.669
Std. Error of Kurtosis		.243
Range		600828.00
Minimum		5700.00
Maximum		606528.00
Sum		34438284.00
Percentiles	25	48480.0000
	50	70680.0000
	75	101076.0000

[a] Multiple modes exist. The smallest value is shown

For a majority of the households, annual incomes were often depleted by the high incidence of negative shocks leaving very little if any, for investment in livelihood-improving or resilience-building activities. Households were observed to be vulnerable to various phenomena and were implementing a number of coping or adaptation strategies with diverse levels of success. The following section presents observations related to vulnerability and adaptation.

[22] These are a cumulation of monthly expenditures calculated based on the average figures reported for the months of February, March, April or May 2009.

4.2 Observed Vulnerability Causes and Coping/Mitigation/Adaptation Strategies

In the area of study, a number of sources of negative shocks were observed. In the long run, some of those observed negative shocks constituted sources of vulnerability and/or fortified other sources of the same. Having been asked to state any natural and/or man-made sources of major disturbances to their lives and livelihoods within the five years prior to the survey, the sources of vulnerability immediately identified by the rural households included environmental degradation (38 per cent of the households) and weather variability (35 per cent of the households).

The remaining 27 per cent mentioned other issues like large rises in prices of consumer goods and of farm inputs, ill health and deaths of people besides livestock robbery. Various drivers of vulnerability identified during literature review like low levels of livelihood; low adaptive capacity; weak social capital; weak institutional organisation and poor governance; and, inequality in the distribution of resources and opportunities (social justice issues) were observed in the area of study alongside other location specific factors (such as heightened restriction of access to forest resources). However, with the limited time and resources available, this dissertation focussed on the leading three causes of vulnerability and the actions taken against the same. It was found out that in the face of the negative shocks and resultant vulnerabilities, the rural households had devised certain coping strategies or adopted various mitigating strategies. The three leading sources of vulnerability observed in the area of study together with the mitigation/coping strategies adopted by the households in the area of study are presented as follows.

1. Land degradation and loss of vegetation

This phenomenon was felt by the households in various ways and it was visible through various signs. Generally, aspects of environmental stress were mentioned as the leading cause of vulnerability by 38 per cent of the respondents in the sample. There were other households that ranked environmental stress issues second or third in a list of three most pressing sources of vulnerability. Going by the experience of the respondents, 83.4 per cent of the respondents felt that the state of the environment had significantly deteriorated over the previous five years. Blaming wanton depletion of vegetation and the resulting increases in soil erosion levels, the respondents reported difficulties associated with land degradation and wood scarcity. The respondents observed that land degradation complemented the adverse effects of

weather unpredictability as well as increased farm input prices to lead to significantly reduced farm output.

Whereas 64.3 per cent of the respondents thought that urgent actions should be taken to reverse the prevalent environmental stress, 35.7 per cent saw it as an ordinary phenomenon with which one should live. Here, it is worth mentioning that higher income households and/or those with higher asset ownership as well as those who had made significant steps to adapt tended to view environmental problems as being 'normal' changes. This could be due to the feeling or thinking by such households that they had accumulated a significant amount of wealth (had flows of income) to deploy so as to cushion them from any deficiencies occasioned by environmental stress issues.

There was a set of coping and mitigation strategies in use against environmental stress issues and loss of vegetation. This included digging of ridges and furrows to control soil erosion and planting Napier grass to hold soil besides being used as cattle feed. The ridges provided raised ground for root crops and Napier grass in areas where top soil layers were thin (stony sub-soils). Some households had planted trees and shrubs to act as wind breakers, control soil erosion and provide firewood yet others used compost/farmyard manure and inorganic fertilizers to replace soil nutrients/minerals lost through leaching and soil erosion. Diversification into other economic activities (such as small scale trading, bicycle/motorcycle taxi and taking up jobs as casual labourers) was also relied on to provide complimentary income to the unpredictable output from the degraded soils. Some respondents had also joined self help groups where they shared information on how to cope with environmental challenges. Self help groups also often pooled funds for lending to members facing negative shocks.

Slightly over 87.3 per cent reported to be undertaking some actions to counteract the negative effects posed by soil degradation with varying levels of success. For the purposes of this dissertation, the effectiveness of employed adaptation measures had to be evidenced by the said households having derived some benefits (e.g. firewood, building timber or sales) from the actions they had taken. Besides the use of manure and commercial farm inputs, tree planting was the other activity commonly mentioned by households as having been effective in their mitigation efforts. Here, 63.3 per cent of the households reported having actually planted more than five trees for firewood and other domestic purposes. Asked whether or not

they would consider planting more trees, 63.8 per cent of the households responded in the affirmative but on condition of access to more land.

Sugar cane and tea farming were slightly cushioned from the impacts of soil degradation due to the fact that the sugar factories supported farmers in securing inputs and some local co-operatives of tea growers also mobilised savings for the purchase of fertilizers and farm inputs. This was particularly observed in Shinyalu and Kabras divisions.

2. Weather and climate variability was reported by 35 per cent of the households as being the leading cause of vulnerability in their lives. Changing climatic patterns are however a regional and global phenomenon some of whose causes lie beyond the borders of the district. Respondents reported to have observed a worsening pattern of erratic rainfall whose onset they could not predict and when the rains arrived, sometimes it was too little or too much. Hailstones were also reported as a related source of problem leading to bean crop losses particularly in Shinyalu division. During the survey period, long rains arrived two weeks later than previously expected (beginning of April 2009 as opposed to the second week of March).

Weather forecasts from the Kenya Meteorological department[23] were reported to be too broad and too general to be helpful with some respondents claiming that the forecasts were rarely accurate. The delayed onset of rains often meant loss of resources and effort since the farming households would be forced to sow seeds a second time[24] in which case any investment in seeds and fertilizers used in the first attempt would be as good as 'lost'. Sometimes, rains disappeared during the growing periods when the plants needed the most moisture. As such, a quarter of the respondents reported having suffered massive crop failure linked to dry weather conditions in the five years prior to the survey. On the link between local weather variability and the global climate change phenomenon, some respondents conceded that local human activities contributed to the prevalent weather and climate variability but a majority (69.2 per cent) generally put the blame on factors beyond their locality which had affected the larger regional climate. A third of the respondents actually linked local climate variability to the global climate change phenomenon which they had heard of in the local electronic media.

[23] The Kenya meteorological department has divided the country into five broad regions for purposes of weather forecast: The Eastern Highlands, the Western Highlands, the Lake region, the Coastal plains and the Rift Valley. Kakamega district experiences weather conditions prevalent within the lake region and the western highlands.
[24] In the long rains period, farmers often sowed at the beginning of March. When rains delay, germination and early growth stages are interfered with.

Apart from some level of income diversification, there were no other tangible mitigation strategies in response to weather and climate variability. Diversification of economic activities into low-income non-agricultural activities like bicycle taxi services appeared to be a kind of coping strategy for lack of any better alternatives especially in cases of small landholder poor households while a few richer households ventured into non-agricultural business activities i.e. retail shops, furniture making and flour milling. Efforts by some NGOs and researchers to promote drought resistant crop varieties like sorghum and millet had not gained meaningful acceptance while the cassava mosaic disease and rodent destruction had affected the production of root tubers that require shorter rain periods to mature.

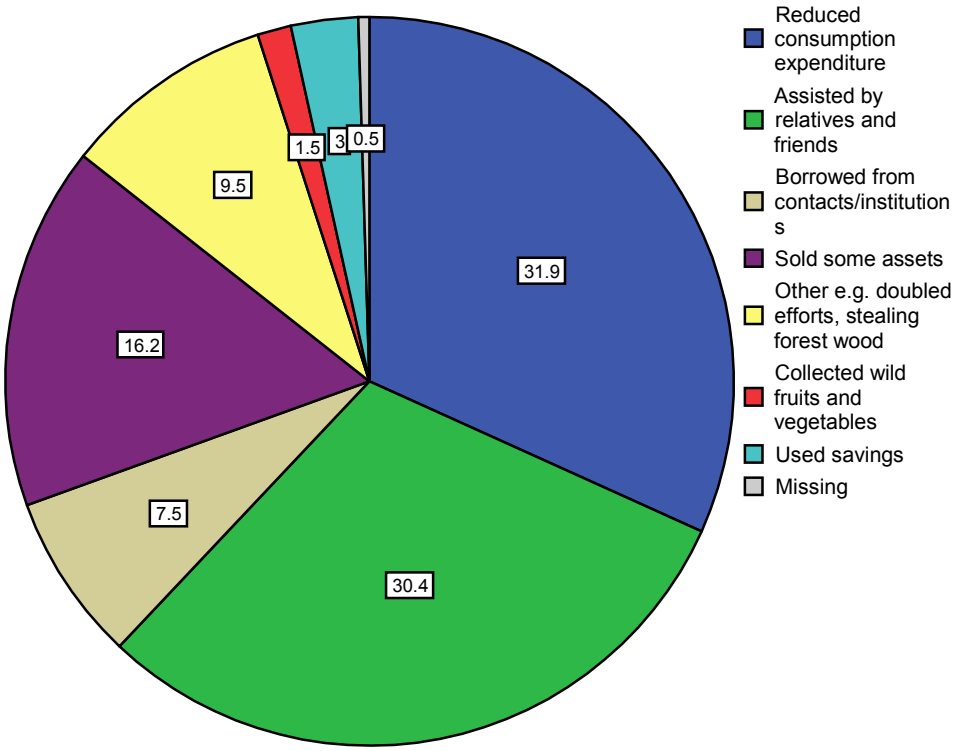
With no reliable idea as to when the rains would fall, most farming households sowed seeds after observing that a reasonable number of other (prominent) farmers had started sowing. This cautious approach to timing of planting was meant to minimise chances of miscalculation but it was not always helpful.

3. From the whole sample, 27 per cent of the households reported that the main sources of vulnerability were other issues like large increases in prices of consumer goods and of farm inputs; weather related diseases such as malaria; ill health; and deaths of people and livestock besides robbery. There were also other longer-term aspects such as danger of respiratory diseases due to use of firewood. For this group of households, issues related to environmental stress and climate variability came second or third. Stricter restriction of access to the forest was also mentioned by some households as a problem that had led to a difficulty in finding firewood and a relative reduction of household income. Before the tightening of restrictions by the Kenyan government on use of the forest (including collection of wood and other items from the Kakamega forest), households obtained significant amounts of income from selling forest products. This last situation can be viewed as deepening the growing scarcity of some natural resource commodities in the area of study. More information on the history of public management of Kakamega forest can be found in annex 2.

Observed coping strategies for this third group of vulnerabilities included: Reducing consumption (referred to by the respondents as ‘tightening their belts’ and similar to what Moser, 1998, refers to as consumption modifying strategies), selling assets, being assisted by relatives and borrowing from relatives, friends and groups. Figure 12 shows a graphical summary of the response and coping strategies adopted by the households in face of the

negative shocks such as large increases in prices of basic commodities or those of farm inputs[25]. Remittances from emigrated members of the extended family and soft loans from relatives, friends, local groups (women groups, church groups, merry go rounds, table banking, burial groups, youth groups and bicycle taxi groups) and organisations were observed to play significant roles in not only helping households pull out of negative shocks but also bridge budgetary gaps.

Figure 12: Means with which Household Overcame Shocks



In an attempt to boost asset base and diversify income sources, some households (19 per cent) had taken small business loans from institutions like the Kenya Women Finance Trust (KWFT) and Equity Bank with a few households displaying sterling examples of success using business loans. Such success stories were observed mainly in Municipality, Ikolomani, Lurambi and Ikuywa divisions and the kinds of businesses observed included maize flour milling, dairy farming as well as timber and vegetable businesses. It was observed that loans had enabled such loanees acquire tools and equipment or buy farm inputs like improved seeds and breeds. Table 11 presents the relevant summary statistics.

[25] In 2008 there was post election violence that disrupted production and distribution leading to high prices.

Table 11: Loan Taken within Last 12 Months Prior to Interview Date

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes and repaying	73	18.1	18.3	18.3
	No	322	79.9	80.7	99.0
	Yes and defaulted	2	.5	.5	99.5
	Yes and completed repaying	2	.5	.5	100.0
	Total	399	99.0	100.0	
Missing	Respondent can't tell	4	1.0		
Total		403	100.0		

However, 'stringent' conditions were reportedly turning off some potential loanees. In face of strict repayment schedules by some lenders like the Kenya Women Finance Trust (KWFT), some loan recipients resorted to borrowing from friends and local women groups to meet their repayment schedules. In some cases, this practice ended up in heavy debt burdens for the borrowing households. There were also cases where business loans had been channelled to consumption expenditure and the loanees defaulted[26]. Some female respondents claimed that it was hard for a mother to see her children go to bed hungry yet she had taken a business loan. There was often internal pressure to use the business money for consumption.

These observations among households that had taken loans suggest at least two things, either or both of which play significant roles in the area of study. On the one hand, they point at a situation where the rates of profit growth within the businesses were too low to guarantee regular repayment besides providing for household consumption needs[27]. On the other hand, inadequate business or financial skills (such as disciplined use of credit) in an environment characterised by a high incidence of negative shocks like diseases, robbery, inflation and death, is also likely to have played a significant role in weakening the ability for regular loan repayment among borrowing households.

As was observed in the area of study, there were frequent numerous shocks which constituted threats to the productive use of business loans. There appeared to be very few if any disciplined loanees, who would insist on keeping their fingers off borrowed business funds in

[26] Such cases of default discourage group formation (group security), an otherwise brilliant attempt to provide alternative collateral security requirements. In the KWFT model, group members are held accountable if one of them defaults.

[27] Among other possibilities, the low profitability among some businesses in the area could be due to small market size or the practice of investing in necessity-based enterprises.

the event of such shocks as deaths of relatives. Most respondents would rather take some money from the business loan (if they have been advanced any) and use it for fare to a funeral of a relative with the hope of replacing the money. As it were, hardly would such recipients be back from the funeral than another 'urgent' negative shock (say illnesses, other deaths, accidents, robbery with violence and bloody conflicts) would occur. Besides, the high incidences of negative shocks reduced the time and energy available for use in economic activities.

The fact that the high incidence of morbidity (negative shocks) was putting to test even some of the most disciplined loanees thereby raising chances of loan defaults was consistent with an observed widespread fear of credit in the area. Only 19 per cent of the households in the sample had taken a loan in the 12 months prior to the survey even though a much higher number displayed a desire for additional finance for various livelihood-enhancing issues. The unpleasant fate of previous loan defaulters who had lost assets once they defaulted was the most discouraging element[28]. Cases of ill-conceived 'investments' were also observed. Some households took loans for legal business activities but invested in the brewing and selling of illicit liquor. In such cases, police fines and extortion depleted the borrowed funds leaving the households worse off. Such events precipitated further borrowing for consumption and eventually led to a debt trap and a poor credit record.

4.3 Role of the Government

Among the positive aspects mentioned about the government was the engagement in awareness creation on prevalent development challenges. Government expenditure via the Constituency Development Fund, reduced costs for expectant mothers and children in health facilities and subsidised education as well as the youth and women funds were mentioned among the worthy positive actions by the government. Others were occasional help to widows and orphans and distribution of subsidised fertilizers and seeds during planting time albeit via a time consuming procedure.

The negative aspects mentioned included being indifferent to some pressing local challenges and the poorly coordinated implementation of policies. Some respondents with low land possession regretted too much government restriction especially seen through the withdrawal

[28] A borrower whose property had been attached quickly became a laughing stalk in the locality and this discouraged many a potential loanees.

of non-resident cultivation (*shamba system* - information on Kakamega forest management is available in annex 2) within Kakamega forest saying this had exacerbated their poverty. Respondents sourcing products from the Kakamega forest mentioned arrests, extortion and rent seeking by forest guards as being some of the negative effects from government agents. They accused well placed corrupt individuals of colluding with forest officers to steal and sell timber from the forest. The respondents living around the forest claimed that they regularly saw 'suspicious' lorry loads of timber leave the Kakamega forest with the blessings of forest officers[29] while locals were not allowed to log freely.

The government was also blamed by respondents due to poor security, high incidences of crime and delays in dispute resolution with most households expressing a kind of lack of faith and trust in formal government institutions. Crimes such as robbery with violence and stock theft had worsened household poverty and therefore weakened adaptability since the resulting injuries led to ill health and medical expenses while lost livestock left behind depleted reserves. Perhaps indicating the limited extent to which the rural households resorted to official government structures, 64.4 per cent of the households which had had major misunderstanding resorted to clansmen and village elders for the resolution of the disputes as compared to 10.4 per cent that resorted to courts or even the 21.7 per cent of the cases in which the assistant chief was involved to find a settlement. This low faith in public structures exhibits substantial institutional weaknesses.

Asked what was hindering them from full mitigation of the prevalent vulnerabilities, most households mentioned limited financial resources and held the view that the government was not doing enough to complement their self-help efforts and yearned for improvements in various areas as summarised in table 12. In the table, observed government role in supporting or impeding adaptation appear in the first column with the '+' or '-' signs in brackets indicating whether the actions were considered to be beneficial (+) or harmful (-) to adaptation. The other columns are headed by alternative actions which households deemed necessary to improve adaptability. The figures inside the table are absolute numbers of households in the sample which advocated for a given alternative as a step to improve household adaptability in face of the current government role (+ or -). In the table, it can be

[29] In a rejoinder, forest officers reported that the government allows controlled profitable exploitation of timber with the proceeds being used to plant more trees. Even though corruption in the process of exploitation forest resources was common, a level of misunderstanding and jealousy appeared to exist among the locals.

seen that over a third (133 out of 403 households) of all the respondents felt that the government was too far to be reached and also desired alternative sources of income.

Table 12: Cross Tabulation - Government Role in Supporting/Impeding Adaptation * Needed Intervention to Improve Adaptation

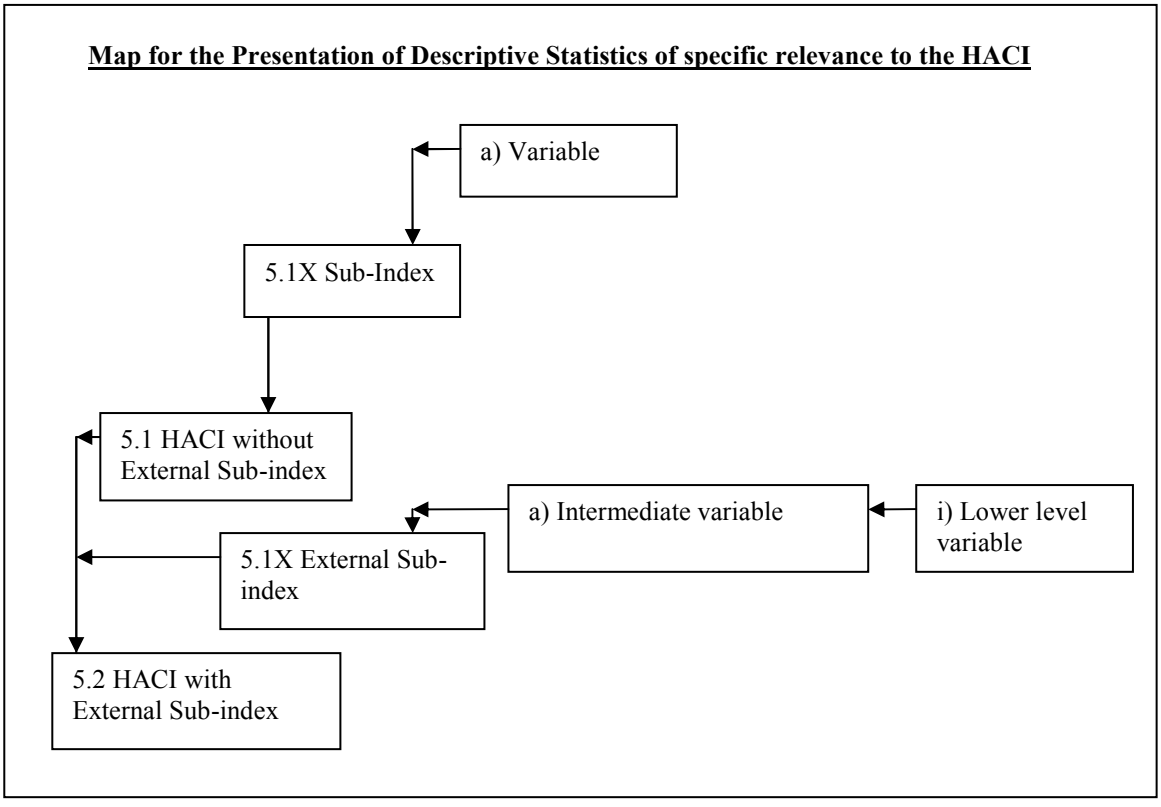
		Needed intervention to improve adaptation						Total
		More awareness creation	More extension services	Provide alternative sources of energy	Provide alternative sources of income	More material benefits i.e. food, clothing, farm inputs	Relocate villagers to better land and leave area for forest	Total
Government role in supporting/impeding adaptation actions	Awareness creation (+)	4	0	2	12	0	0	18
	Too far to be reached (-)	4	2	4	133	8	0	151
	Unclear policy direction (-)	2	5	9	56	1	0	73
	Too much restriction (-)	6	3	10	44	8	0	71
	Other e.g. too much bureaucracy (-)	2	0	0	14	0	2	18
	Insensitive to people's challenges (-)	2	7	18	37	8	0	72
Total		20	17	43	296	25	2	403

Households in areas with rocky/stony land and those with minute acreages tended to advocate for relocation to other arable lands as the most appropriate action needed to improve their situation. This was particularly observed in Ikuywa (Ileho) where a significant number of households planted trees on their stony plots for lack of a better crop. Older respondents preferred material assistance (hand-outs: Food, shelter, clothing and medical care) while younger respondents tended to prefer more alternative income sources. Established and profitably working/farming/trading respondents tended to prefer provision of alternative sources of energy.

5.0 Rural Household Adaptive Capacity

In line with the framework for the HACI presented in chapter 2 data, processing using the statistical package for the social sciences (SPSS) yielded the values of the variables. This chapter presents the calculated HACIs of the households in the sample and the tests of the study hypotheses as well as an elucidation of the factors and strategies associated with high household adaptive capacity indices. The descriptive statistics of the variables, sub-indices and the index itself are presented in the order illustrated in the following map. In order to bring out the effects of the external factors, a presentation of the HACI without external factors is made and then the external factors are included later on. For a better understanding, the descriptive statistics presented hereunder should be read while referring to tables 4a and 4b.

Figure 13: Presentation Map



5.1 The Household Adaptive Capacity Index (HACI) without External Sub-index

Using the framework presented in chapter three, the values of the household adaptive capacity indices were calculated for all the 403 households in the sample. This section presents some

of the descriptive statistics for the variables of the sub-indices of the HACI, those of the sub-indices themselves as well as those for the HACI.

5.11 Household Wellbeing and Stability

The descriptive statistics of the variables that make up the household wellbeing and stability sub-index were as follows.

a) Market Value of Assets

The category for the total monetary value of moveable and non-moveable assets was used as an indicator for this variable. Total monetary value of household assets and durable goods fell in one of five categories roughly corresponding to low, lower middle, middle, upper middle and high monetary value of assets and durable goods. Briefly put, over 75 per cent of the households owned assets and durable goods whose total monetary value was less than KES 250,000 (therefore fitting into the low and lower middle categories). A tabular presentation of the asset information follows.

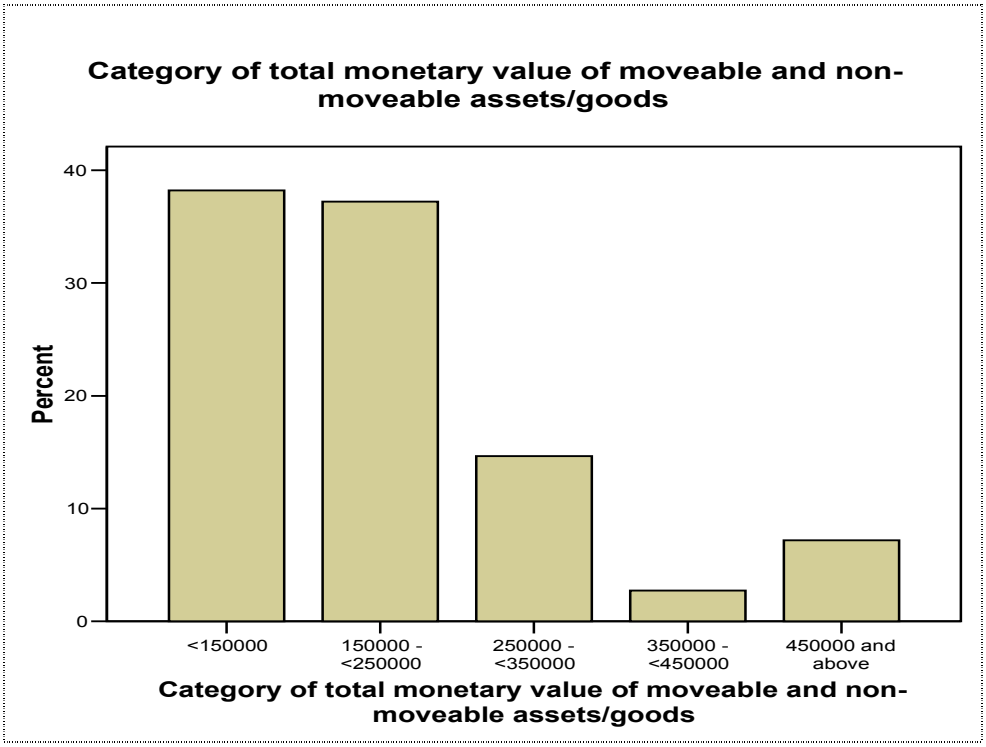
Table 13: Statistics of Market Value of Assets

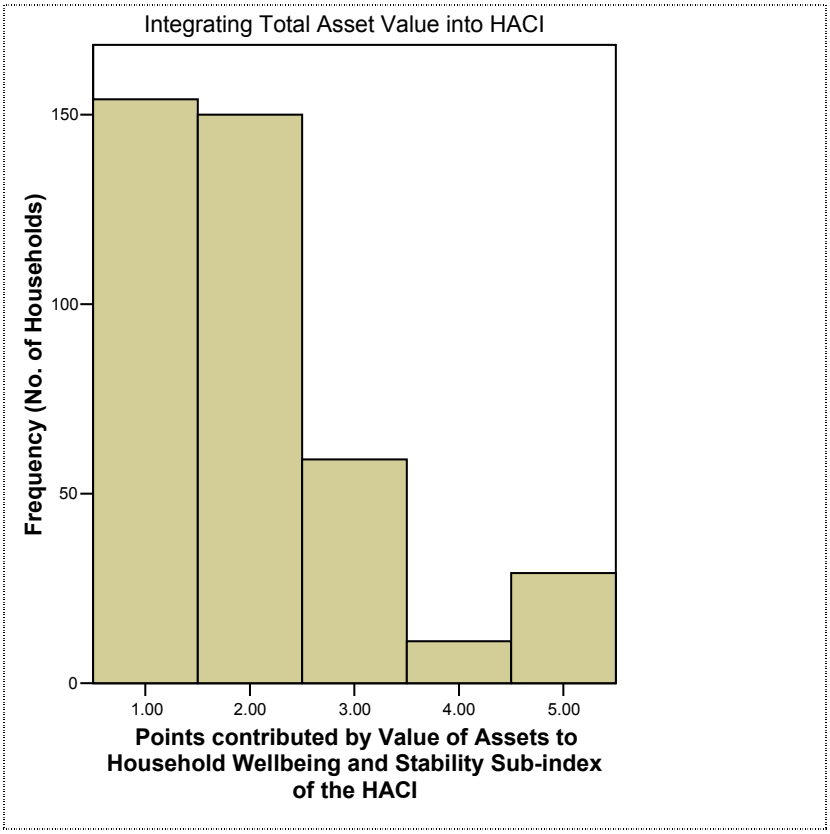
Category of total monetary value of moveable and non-moveable assets/goods

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<150000	154	38.2	38.2	38.2
	150000 - <250000	150	37.2	37.2	75.4
	250000 - <350000	59	14.6	14.6	90.1
	350000 - <450000	11	2.7	2.7	92.8
	450000 and above	29	7.2	7.2	100.0
	Total	403	100.0	100.0	

Where total monetary values of asset possessions were in the lower levels, households were not guaranteed of an adequate flow of incomes necessary to cope with or resist the impact of negative environmental changes. As already explained in chapter 2, available literature shows that households dispose off their assets and goods in order of reducing permanence so as to deal with negative shocks. Negative environmental changes (environmental stress) being a source of negative shocks (among other things, they often lead to aridity and poor harvest hence inadequate food and reduced income); households displaying low total monetary value of assets were seen to be in weaker positions to adapt or cope with adverse environmental situations.

Figure 14: Bar Graphs on Market Value of Assets





By the foregoing reasoning, it can be seen from the above two graphical presentations of the information on total monetary value of household assets and goods, that asset (and goods)

ownership provided a less than average contribution to the household wellbeing and stability sub-index for a great majority of households in the area of study (thereby precipitating lower HACIs). Going by the quantification applied for this variable (summarised in table 4a), the just presented frequency distributions indicate that 38.2 per cent of the households had a contribution of 1 point from this variable to the sub-index (household wellbeing and stability), 37.2 per cent of the households had a contribution of 2 points, 14.6 per cent of the households had 3 points, 2.7 per cent of the households had 4 points while 7.2 per cent of the households had the maximum 5 point contribution to the sub-index due to the fact that the value of their assets and goods was KES 450,000 and above.

b) Land Rights

Possession of a title deed as proof of land ownership is important when seeking loans for investment. When well managed, access to loans may play a positive role in promoting investment, business development, income diversification and fighting negative shocks. Observations from the area of study showed that only a third of the households in the sample had title deeds as proof of their rights over land and which they could use as collateral security. Viewed from the premise that title deeds are important to household wellbeing and stability to the extent that the titles are the most widely accepted type of collateral security when seeking loans from financial institutions, this observation effectively implies that more than two thirds of the households had no secure titles to land and therefore were in a relatively weak position to access meaningful loans. The following frequency table and figures provide summaries.

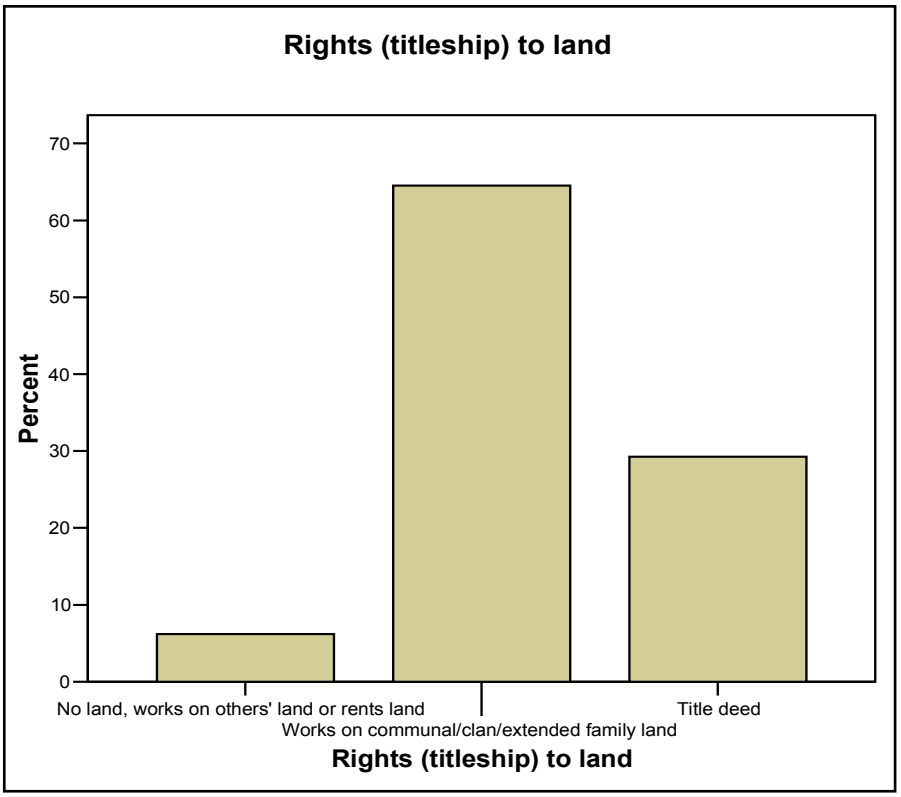
Table 14: Rights to Land

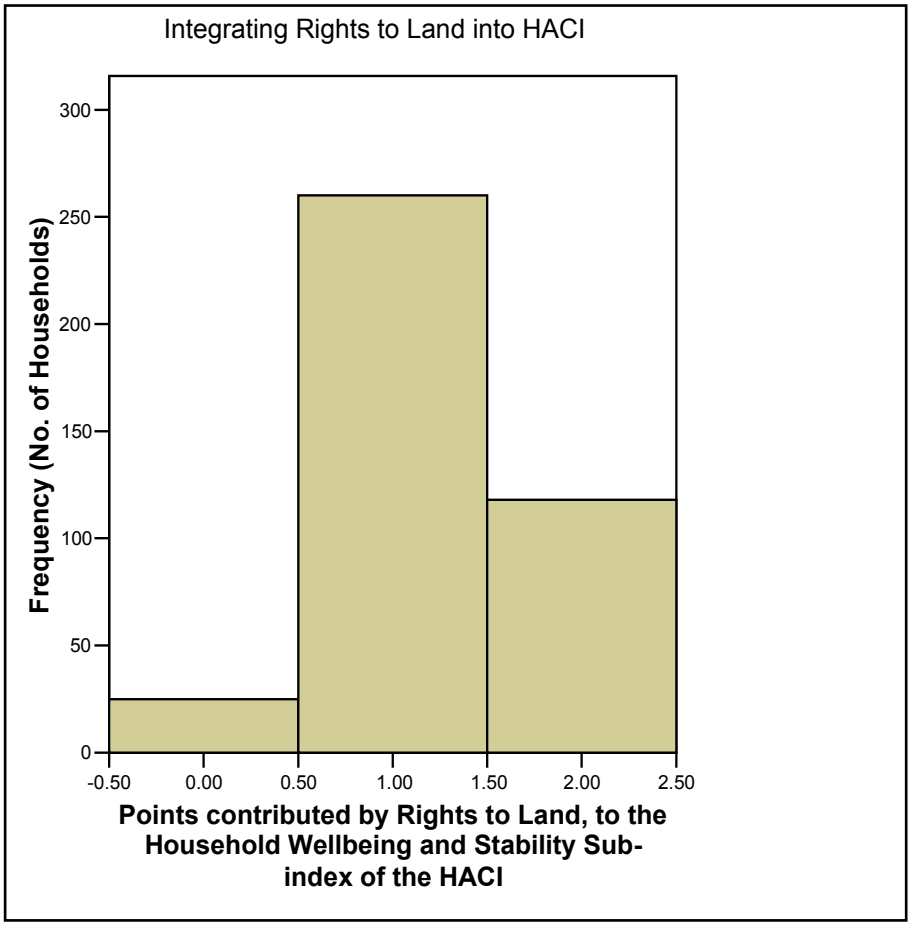
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No land, works on others' land or rents land	25	6.2	6.2	6.2
	Works on communal/clan/extended family land	260	64.5	64.5	70.7
	Title deed	118	29.3	29.3	100.0
	Total	403	100.0	100.0	

Slightly more than 6 per cent of the households owned no land[30] (depended on good will of others to find plots to plough) while 64.5 per cent shared inherited land (had joint claims).

[30] In the developing countries with no welfare (unemployment) transfers, lack of land in combination with unemployment is often tantamount to destitution.

Figure 15: Bar Graphs on Rights to Land





Given the measurement scale for this variable, slightly less than 30 per cent of all the households in the sample obtained a contribution of two points to the sub-index due to their possession of ready collateral security in form of a land title deed. The majority (64.5 per cent) of the households had claims on inherited extended family (clan) land and this added a point to the sub-index for each of these households due to the fact that they had some claims to land. Some households rented out their portions of clan land and used the money obtained to fight negative shocks.

c) Income diversification

The more diversified a household's income sources are, the more stable its economic wellbeing is likely to be. Households in the study area appeared to have made efforts to diversify their incomes since 77 per cent had two or more sources and only about 33 per cent depended on a single source. The following table and figures present the summary statistics.

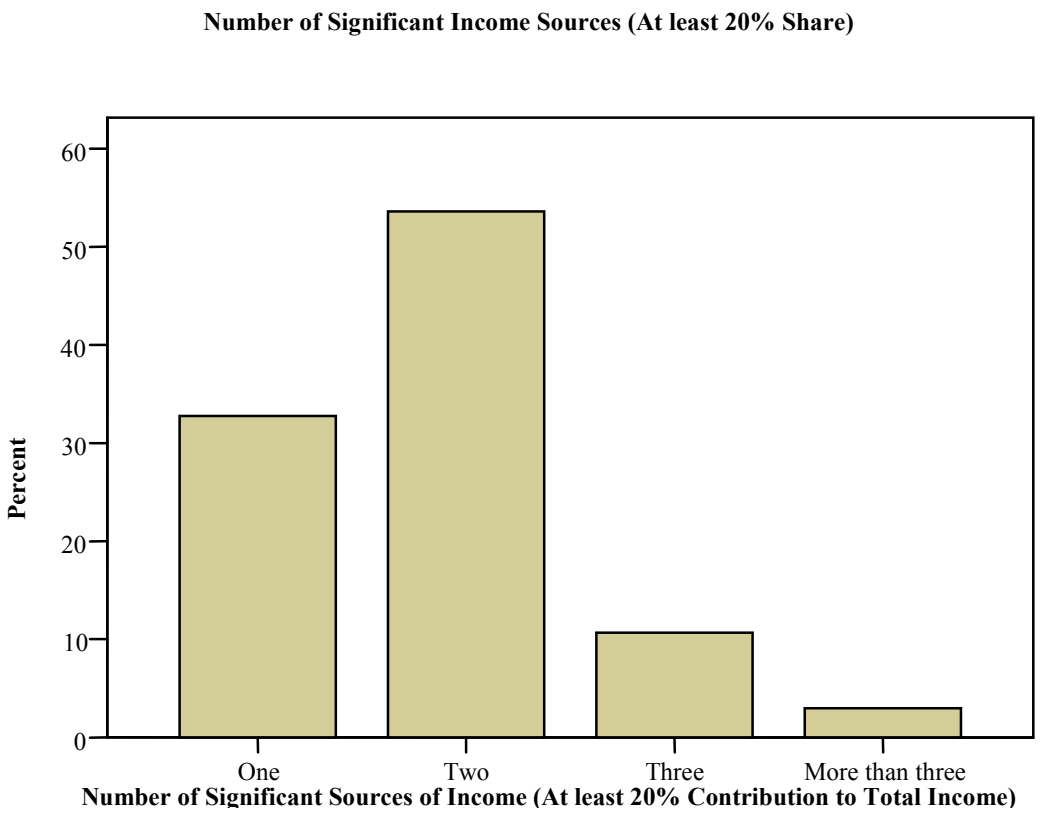
Table 15: Number of Significant Sources of Income (At least 20% Share)

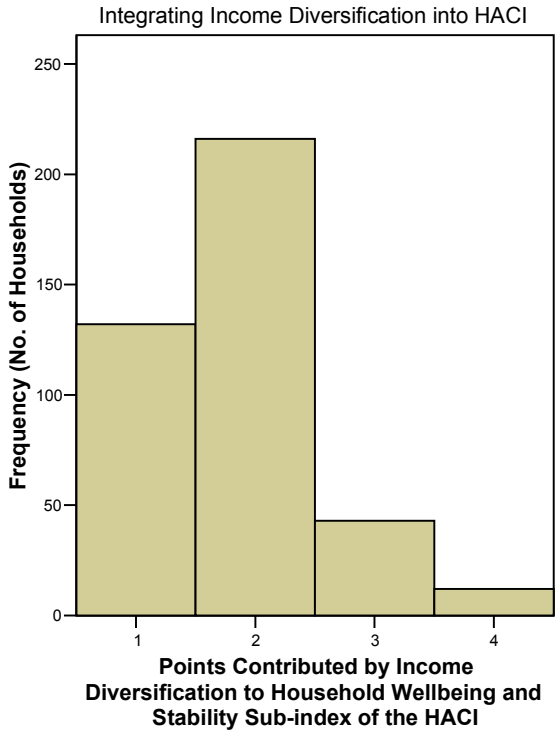
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	One	132	32.8	32.8	32.8
	Two	216	53.6	53.6	86.4
	Three	43	10.7	10.7	97.0
	More than three	12	3.0	3.0	100.0
	Total	403	100.0	100.0	

Household income sources often included farming and some forms of non-farm economic activities such as small scale trading in fast moving consumer goods, bicycle taxi, employment as casual labourers or even permanent employment. Simple forms of value addition for instance, through processing of agricultural produce like coffee (grounding locally produced coffee berries and selling coffee) and fruits (making and selling salads) were also observed. Among the more capital or knowledge intensive sources of income (businesses) observed were hair salons, barber shops, shoe repair, bicycle and motorcycle, repair, tailoring, carpentry (wood work), flour milling and welding (metal work).

Most likely due to resource limitations (land, labour, capital and know-how) two was the modal number of income sources but higher numbers were also observed as may be seen in the following frequency distribution figures. The contribution of this variable to the sub-index has also been graphically summarised on the next page.

Figure 16: Bar Graphs on Income Diversification





A value of 4 for income diversification (corresponding to four significant income sources), contributed four points to the sub-index (household wellbeing and stability) compared to only one point contributed by the variable in case of a household with only one significant source of income.

d) Healthy Household Members

About 70 per cent of the households in the sample had members in fairly good health conditions (working or able to work at that particular time) while 30 per cent of the households had a less than optimal share of members of good health or fitness to work so as to maintain or improve household wellbeing. The following tabular summary presents this information.

Table 16: Health in Households

State of health of members (percentages of those in healthy conditions to work)

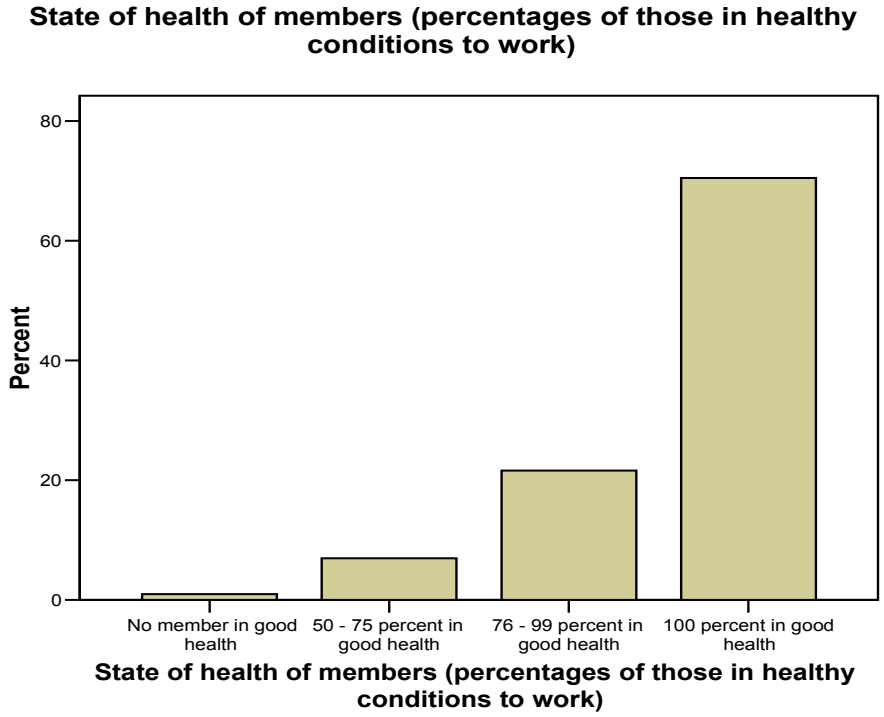
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No member in good health	4	1.0	1.0	1.0
	50 - 75 percent in good health	28	6.9	6.9	7.9
	76 - 99 percent in good health	87	21.6	21.6	29.5
	100 percent in good health	284	70.5	70.5	100.0
	Total	403	100.0	100.0	

The sale of labour, migration (coupled with remittances) as well as sale of assets enable households to deal with negative shocks and are therefore critical in building resilience and adaptive capacity over time. For this reason, the presence of healthy and fit household members who can engage in gainful employment is an important form of 'reserve' (adaptive capacity enhancing factor) which can be drawn upon to enhance coping or adaptation. It is worth mentioning that the other side of the coin - the number of household members who cannot work for reasons of age or ill-health is a factor that hurts household adaptive capacity and has been captured in the sub-index 'household dependency burden'.

If household health is loosely defined as the share of household members in good-enough health status to immediately engage in gainful employment, then it can be seen in the following figures, that about 70 per cent of the households in the sample enjoyed good health, 21.6 per cent enjoyed approximately 75 per cent level of health (fitness to work). Around 7

per cent enjoyed 50 – 74 per cent level of health (fitness to work) while 1 per cent displayed a total lack of fitness to work. The contribution of these various levels of household health to the sub-index (household wellbeing and stability) has also been graphically shown as follows:

Figure 17: Bar Graphs on Health in Households



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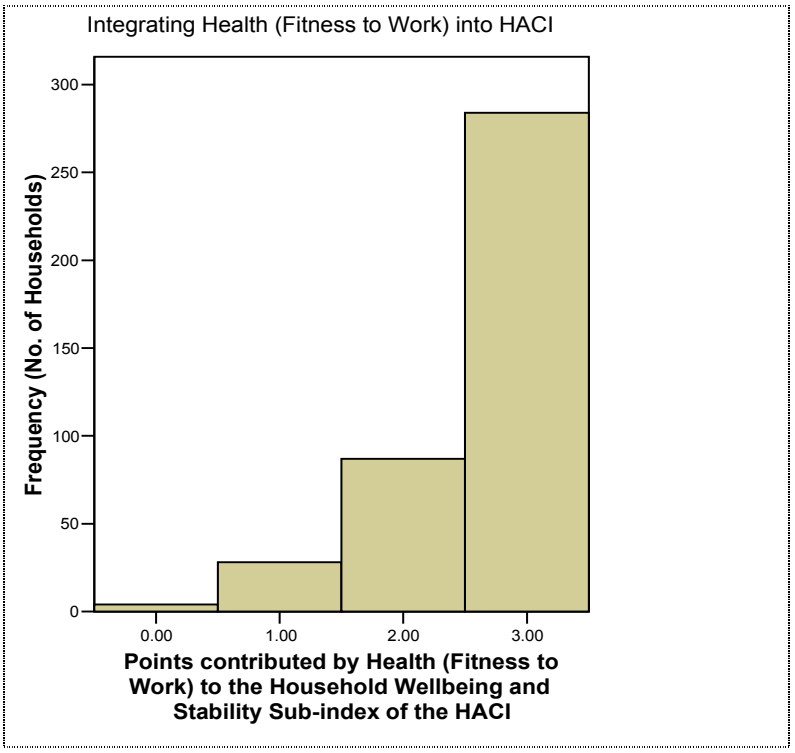


The households' optimal (100 per cent) state of health (fitness to work) yielded 3 points in form of contribution from this variable to the sub-index (household wellbeing and stability) while those with poor health (no members in good health to work) were assigned a value of 0 (zero) and therefore attained no positive contribution to the sub-index.

e) Training of Household Members

Since the returns to labour depends on quantity and quality of labour and because wages enhance adaptive capacity the level of training in each household was assessed. As already explained in chapters two and three, the percentage of household members who had completed secondary school level of education was used as an indicator of the level of training present in a household[31]. The study assessed the percentage of members with 'secondary-school-complete and above level of education' in each household. The following tabular summary of the descriptive statistics shows that only about 29 per cent of the households featured a significant[32] level of possession of secondary-school-complete level of education.

Table 17: Training in Households

Education/Training of household members

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 %	287	71.2	71.2	71.2
	1 - 25 %	70	17.4	17.4	88.6
	26 - 50 %	28	6.9	6.9	95.5
	51 - 75 %	14	3.5	3.5	99.0
	76 - 100 %	4	1.0	1.0	100.0
	Total	403	100.0	100.0	

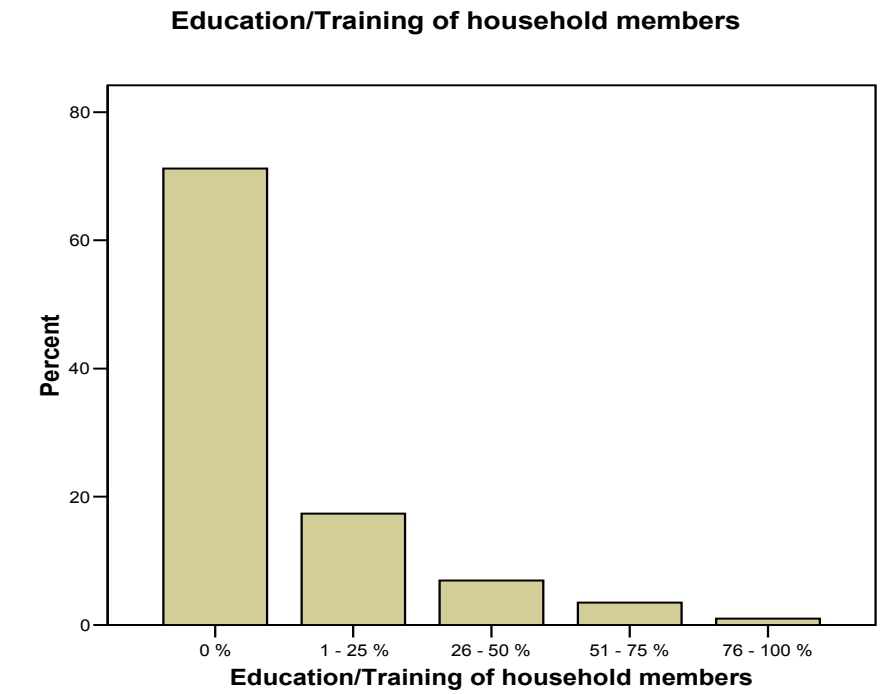
As visible in the above table and graphically presented in the following frequency distribution figures, a great majority (70 per cent) of the households had no secondary-school-complete level of education [33](no member had finished secondary school).

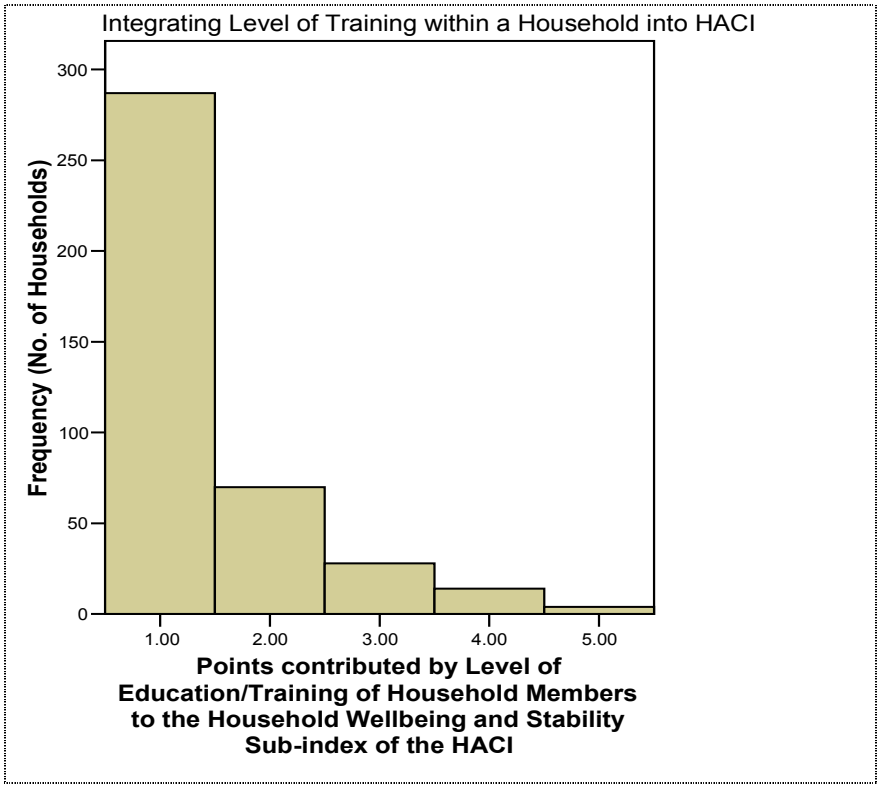
[31] In Kenya, as in many countries, a secondary school certificate is a prerequisite for tertiary training. Hence the choice of the secondary school level of education as a reference level. Previous research in the area of study also showed that the level of education of a household head had a positive impact on household livelihood only after a successful completion of the secondary school level. However, some primary school leavers and secondary school drop-outs also get training in areas like welding, carpentry and tailoring via local polytechnics and apprenticeship enabling them to earn a leaving as artisans. This group have been provided for in the scaling system used.

[32] Significant or meaningful/substantial level of education is one characterised by some form of noticeable benefit to household wellbeing i.e. facilitation of jobs, informed decision.

[33] Emigration of educated children to urban areas once they establish their own households may have contributed to this situation in which a majority of households residing in rural areas feature very low education levels.

Figure 18: Bar Graphs on Training in Households





If, for instance, a household had 9 members out of which one member had completed secondary school, then the level of training/education in the household would be 11 per cent placing the household in the category of 1 – 25 % in terms of level of training. With the scales applied, 1 – 25% level of training ensures that this variable (training of household members)

contributes 1 point to the sub-index (household wellbeing and stability). The distribution of points (contribution from the variable – level of training in the household – to the sub-index – household wellbeing and training) has been graphically shown in the just presented frequency distribution graphs. As shown, households with the highest levels of training had a contribution of five points from this variable to the sub-index while those with the lowest levels of training had a contribution of one point from this variable to the sub-index.

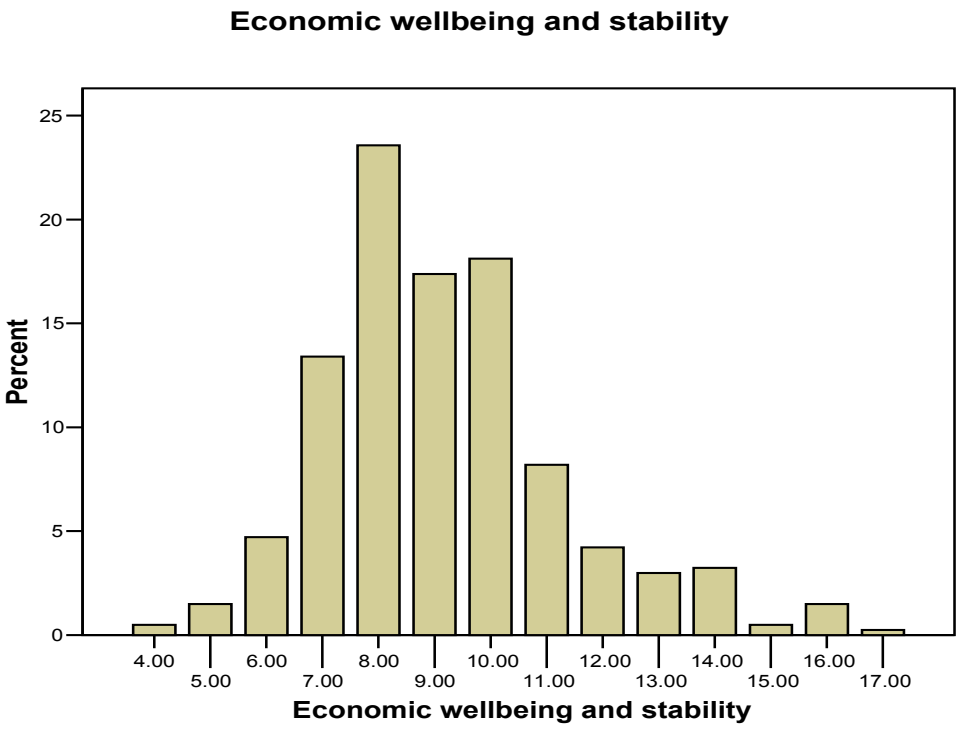
By aggregating the points contributed by the five variables (monetary value of assets, title to land, income diversification, number of healthy household members and level of training of household members) making up the economic wellbeing and stability sub-index, the individual values of the sub-index were obtained (brief presentation follows).

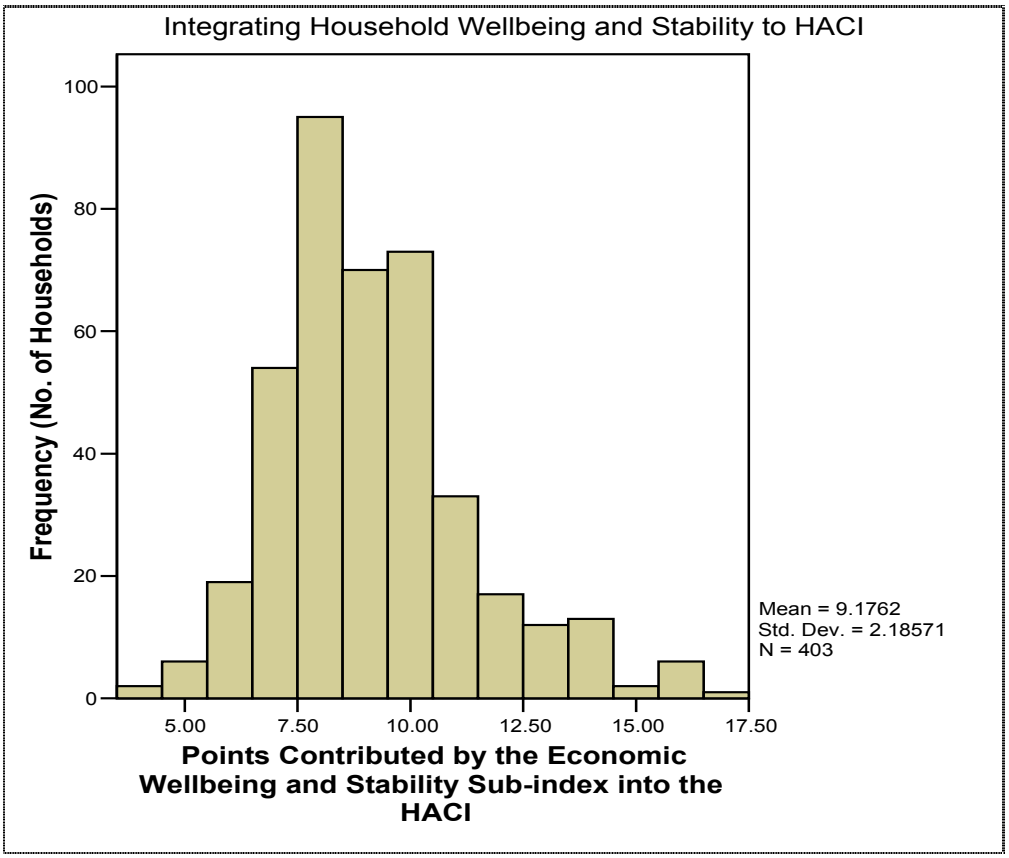
Household Economic Wellbeing and Stability: With its contributing variables having displayed the characteristics presented in the just completed section, this sub-index showed the features summarised in the following table and figures. From the tables and figures, it can be seen that over 60 per cent of the households in the sample obtained contributions of 9 points and below from this sub-index (household economic wellbeing and stability) into their respective HACIs.

Table 18: Distribution of Economic Wellbeing and Stability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.00	2	.5	.5	.5
	5.00	6	1.5	1.5	2.0
	6.00	19	4.7	4.7	6.7
	7.00	54	13.4	13.4	20.1
	8.00	95	23.6	23.6	43.7
	9.00	70	17.4	17.4	61.0
	10.00	73	18.1	18.1	79.2
	11.00	33	8.2	8.2	87.3
	12.00	17	4.2	4.2	91.6
	13.00	12	3.0	3.0	94.5
	14.00	13	3.2	3.2	97.8
	15.00	2	.5	.5	98.3
	16.00	6	1.5	1.5	99.8
	17.00	1	.2	.2	100.0
	Total	403	100.0	100.0	

Figure 19: Bar Graphs on Economic Wellbeing and Stability





In the frequency distribution of the input from the sub-index (economic wellbeing and stability) into the HACI (provided in figure 19), a value of 2.5 points for the sub-index means

that the household in question is in a poor state of economic wellbeing and stability thereby displaying a weak contribution to the HACI while a value of 17.50 is consistent with a relatively high level of economic wellbeing and stability which is also associated with a high HACI.

5.12 Dependency Burden

This sub-index captured the burdening effect from ill-health and non-working household members on the HACI. The two indicators (variables) for this sub-index were:

a) Household Members with Terminal Illness

Ill-health comes with expenditure on medication and care-giving. One third of the households reported significant negative impacts on their livelihoods arising from illnesses such as diabetes, cancer, HIV/AIDS and tuberculosis. Loss of hours, depletion of assets and impaired concentration on economic activities were some of the readily mentioned ill-health related issues impacting household adaptability. The following table and figures summarise the statistics of this variable.

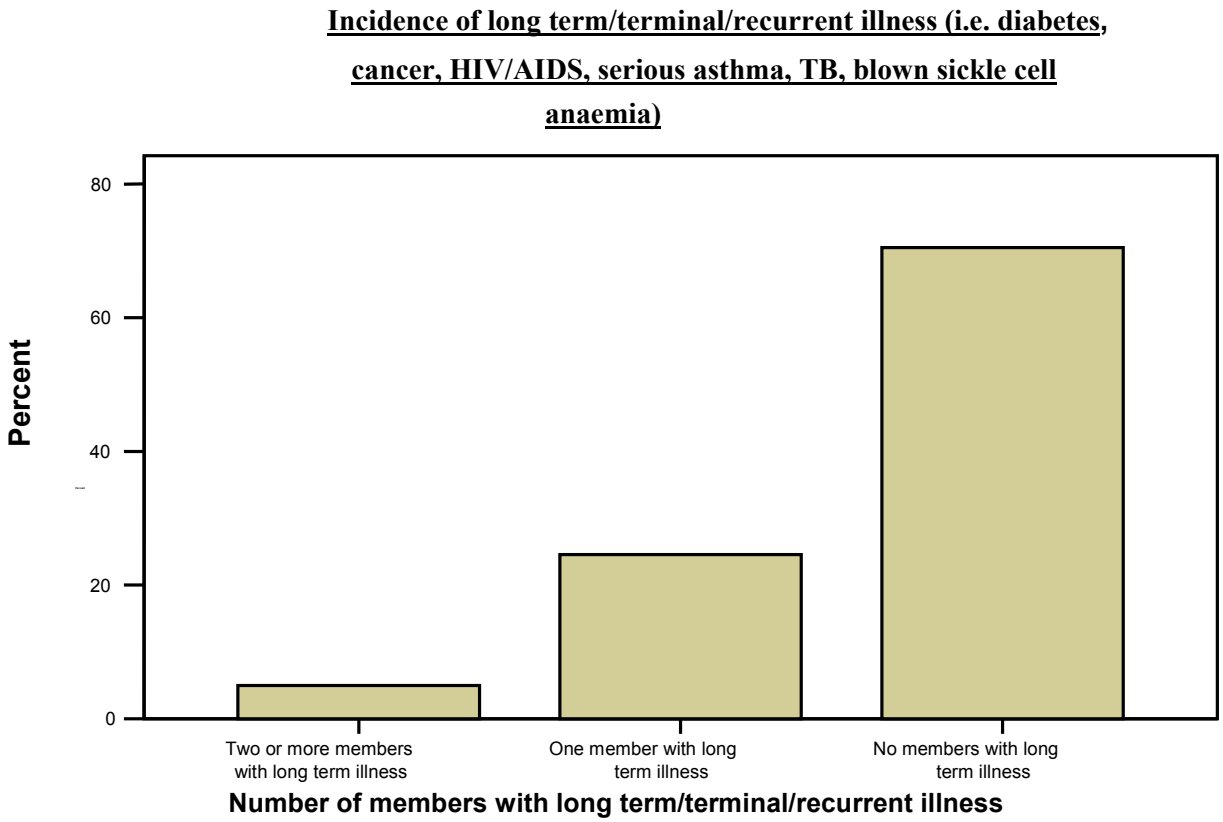
Table 19: Incidence of Terminal Illnesses

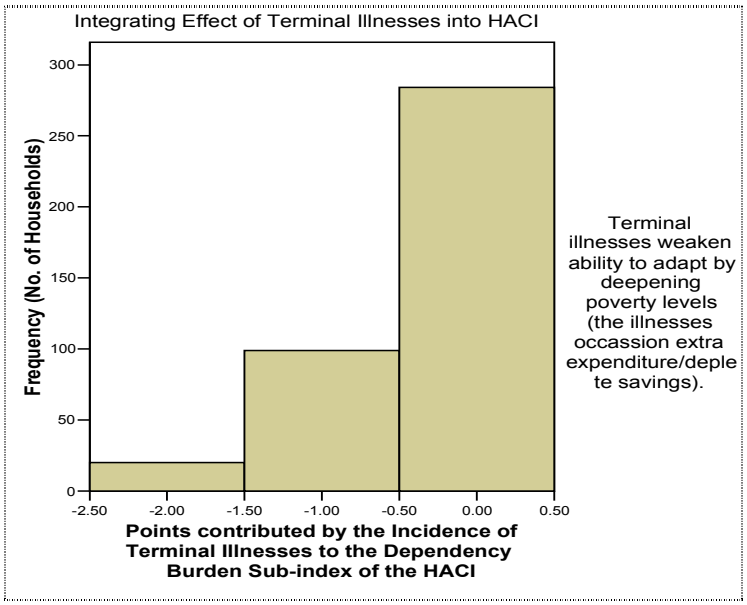
Incidence of long term/terminal/recurrent illness (i.e. diabetes, cancer, HIV/AIDS, serious asthma, TB, blown sickle cell anaemia)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Two or more members with long term illness	20	5.0	5.0	5.0
	One member with long term illness	99	24.6	24.6	29.5
	No members with long term illness	284	70.5	70.5	100.0
	Total	403	100.0	100.0	

The effects of HIV/AIDS, tuberculosis, epilepsy, diabetes, hypertension and old/unhealed physical injuries were the most common ill-health conditions affecting 30 per cent of the households in the sample. Approximately 5 per cent of all the households had two or more members suffering from a long-term illness while 24.6 per cent featured one member afflicted by long term ill health conditions. The following frequency distributions graphically present this information besides displaying how the impact of terminal illnesses within households has been in integrated into the HACIs.

Figure 20: Bar Graphs on Incidence of Terminal Illnesses





The variable - incidence of terminal illness – saw households with two or more terminally ill members make contributions of -2 (negative two) to the sub-index (dependency burden) with

those with single terminally ill members making contributions of -1 (negative one) to the sub-index.

b) Non-working household members

From the assessment of the extent to which non-working household members weakened household adaptability, descriptive statistics showed that 16.6 per cent of the households had a high burden to shoulder while slightly over 83 per cent had a lower burden consistent with 'less than three adult dependants'[34]. The following table and figures summarise the descriptive statistics for this variable.

Table 20: Number of Non-Working Household Members

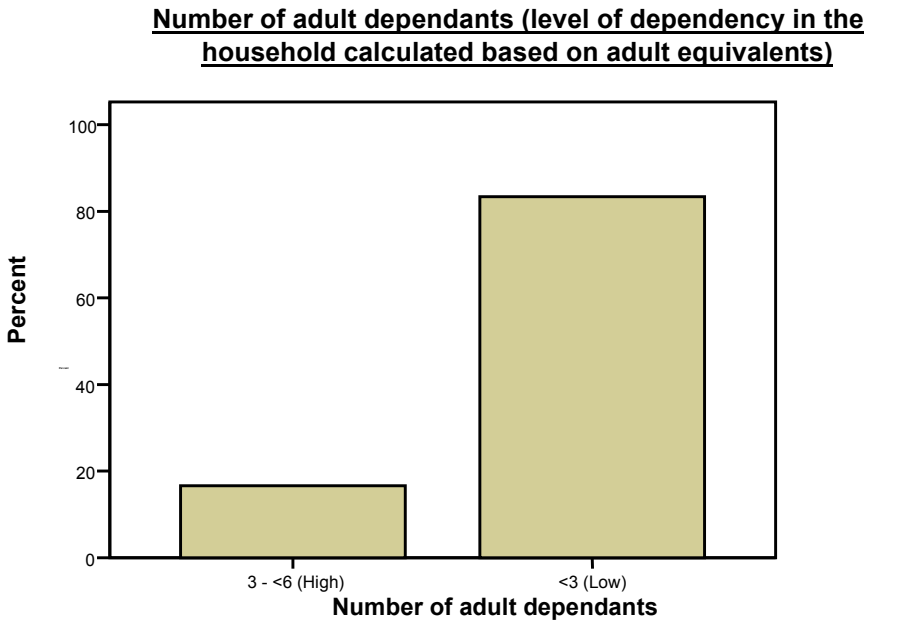
Number of adult dependants (level of dependency in the household calculated based on adult equivalents)

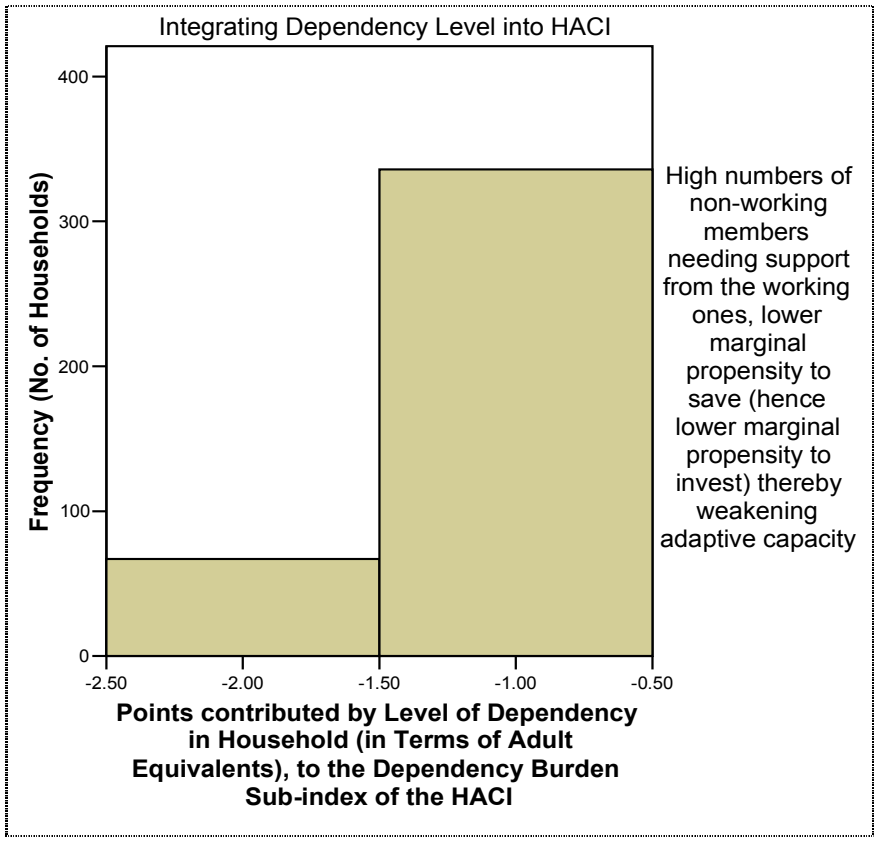
Number		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 - <6 (High)	67	16.6	16.6	16.6
	<3 (Low)	336	83.4	83.4	100.0
	Total	403	100.0	100.0	

Given the measurement system used for this variable, a high number of dependants (3 – 6 persons) gave rise to a contribution of -2 (negative two) to the sub-index (dependency burden) while a low number of dependants (less than 3 persons) gave rise to a contribution of -1 (negative one). The following frequency distribution graphs provide further information on observations relating to this variable.

[34] The concept of adult equivalents was used in the calculations (converting child dependants to an approximate figure of grown-ups using a weighing system). This introduces more practicality and facilitates comparison.

Figure 21: Bar Graphs on Non-Working Household Members





Dependency Burden as a Composite Sub-index: By aggregating the contributions from the two component variables, it turned out that slightly over 39 per cent of the households had negative contributions of between 2 – 4 points to the HACIs arising out of the incidence of ill-

health and/or presence of non-working members. About 60 per cent had negative contributions of a point each from this sub-index. In the following table and frequency distribution graphs, the summary statistics of the sub-index are presented.

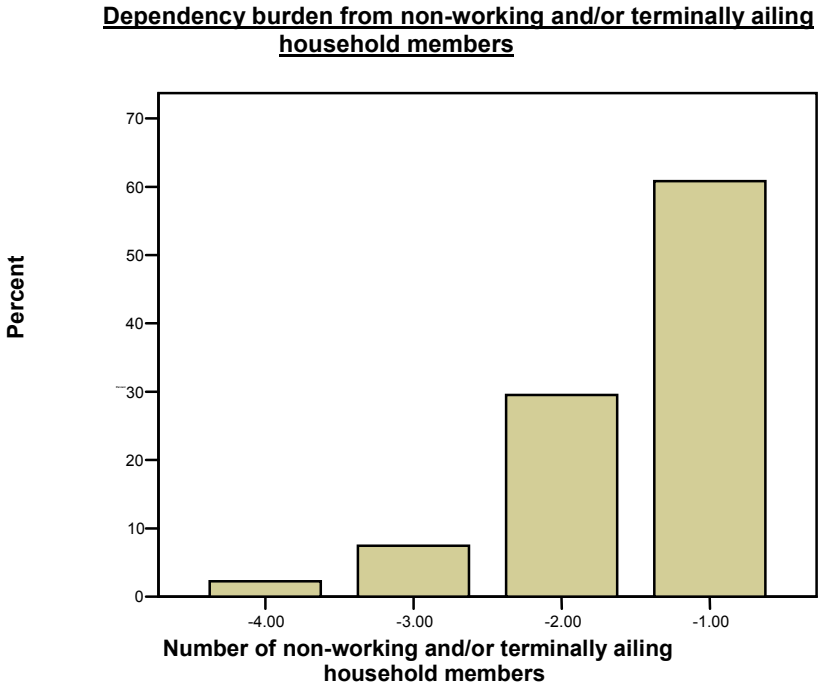
Table 21: Household Dependency Burden

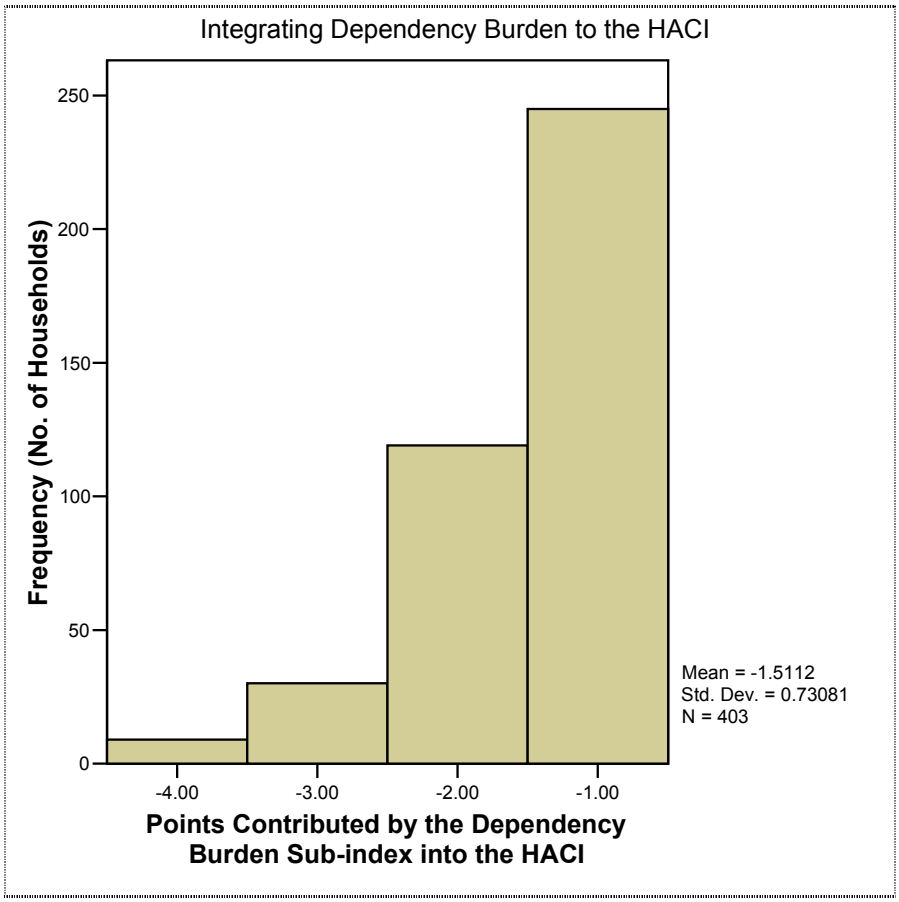
Dependency burden from non-working and/or terminally ailing household members

Number		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-4.00	9	2.2	2.2	2.2
	-3.00	30	7.4	7.4	9.7
	-2.00	119	29.5	29.5	39.2
	-1.00	245	60.8	60.8	100.0
	Total	403	100.0	100.0	

This information is graphically displayed in the following frequency distribution graphs which also show the contributions of the dependency burden sub-index to the HACI. The absence of an observation of 0 (zero) indicates that the adaptive capacity of each of the households was negatively affected by the level of dependency present in each of those households.

Figure 22: Bar Graphs on Household Dependency Burden





5.13 Interconnectivity to higher level processes

Here, the statistics of household possession of reliable contacts in other geographical locations, number of groups to which household members belong and the social groups on which a household relies for help in times of problems like increased negative effects of environmental stress and climate variability are presented.

a) Geographical scope of social capital contacts

Whereas nearly 35 per cent had no reliable contacts away from their own locality, over 58 per cent had at least one reliable contact in other areas, cities or countries. Barring the simultaneous occurrence of negative shocks on both the household at the area of study and to its contacts in other areas, such contacts could be relied upon to help improve a household's adaptability through remittances and information among other things. The following table and figures summarise the descriptive statistics of this variable.

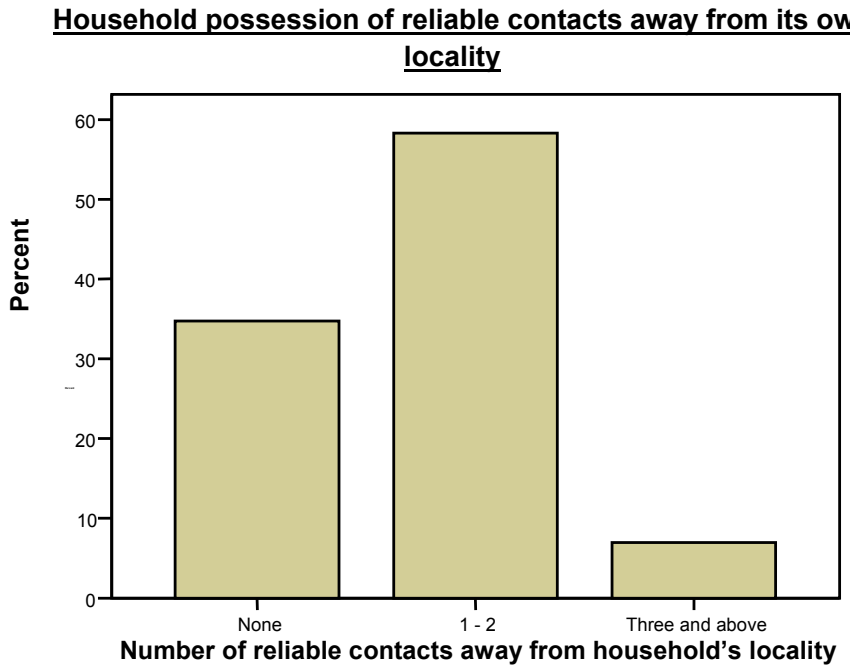
Table 22: Social Capital Contacts away from Household Locality

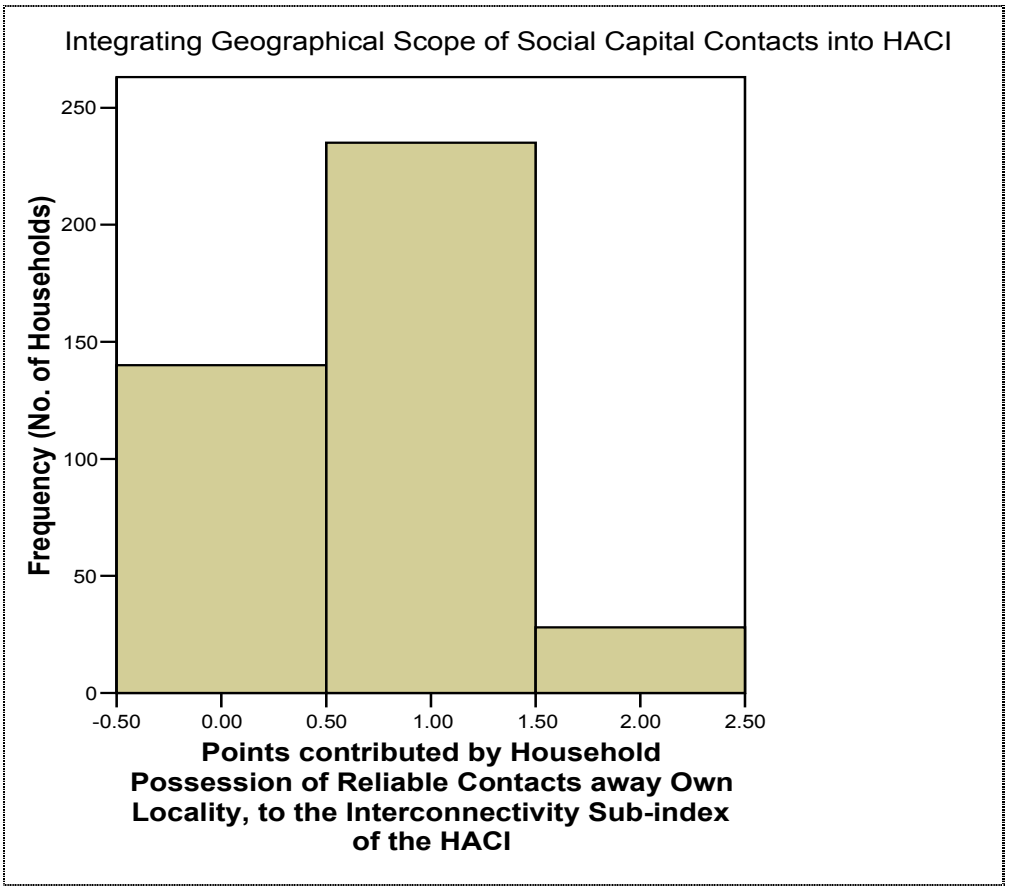
Household possession of reliable contacts away from its own locality

Number		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	140	34.7	34.7	34.7
	1 - 2	235	58.3	58.3	93.1
	Three and above	28	6.9	6.9	100.0
	Total	403	100.0	100.0	

Lack of reliable contacts away from the household's locality was assigned a value of zero (no contribution to the sub-index of interconnectivity to higher level processes). In cases of households with one or two reliable contacts away from its own locality, this variable contributed a point to the sub-index (interconnectivity to higher level processes) while two points were contributed by the variable in cases of households with three or more reliable contacts away from its own locality. Only about 7 percent of the households in the sample had three or more contacts in other areas. The following frequency distribution graphs for possession of reliable contacts away from locality gives a graphical summary of the information.

Figure 23: Bar Graphs on Possession of Contacts away from Households' Locality





b) Number of groups to which at least a household member belongs

Groups appeared to play a critical role in the welfare of households with over 50 per cent of the households belonging to two or more groups. Apart from networking benefits such as information exchange, groups constituted a form of social capital and most households reported that they could borrow from their groups during bad times or in cases of emergencies. The statistics are summarised in the table and figures below.

Table 23: Number of Groups to which Household Member(s) Belong

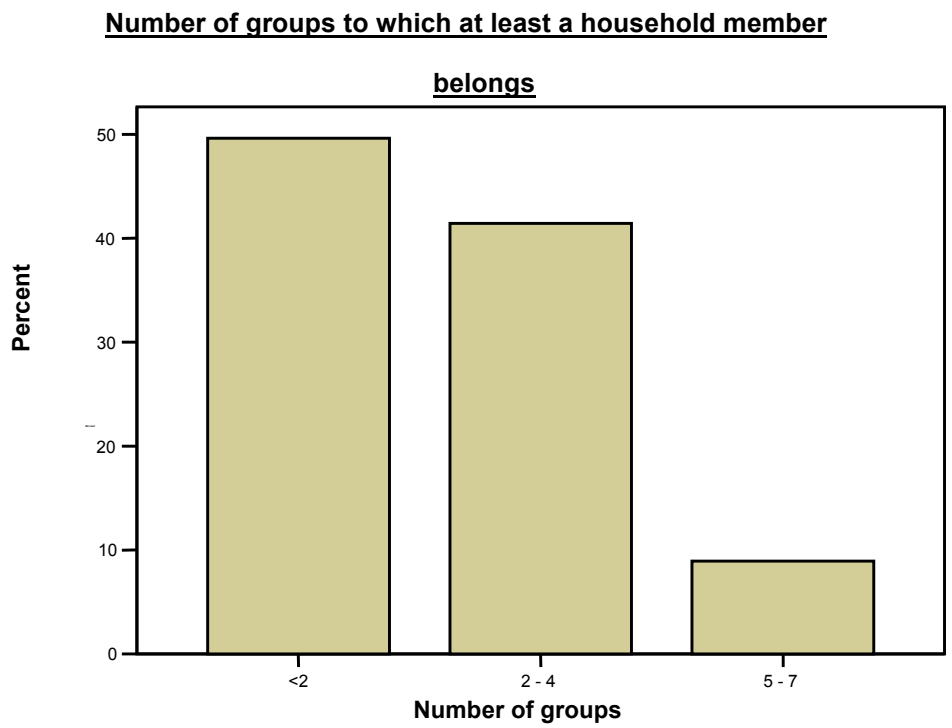
Number of groups to which at least a household member belongs

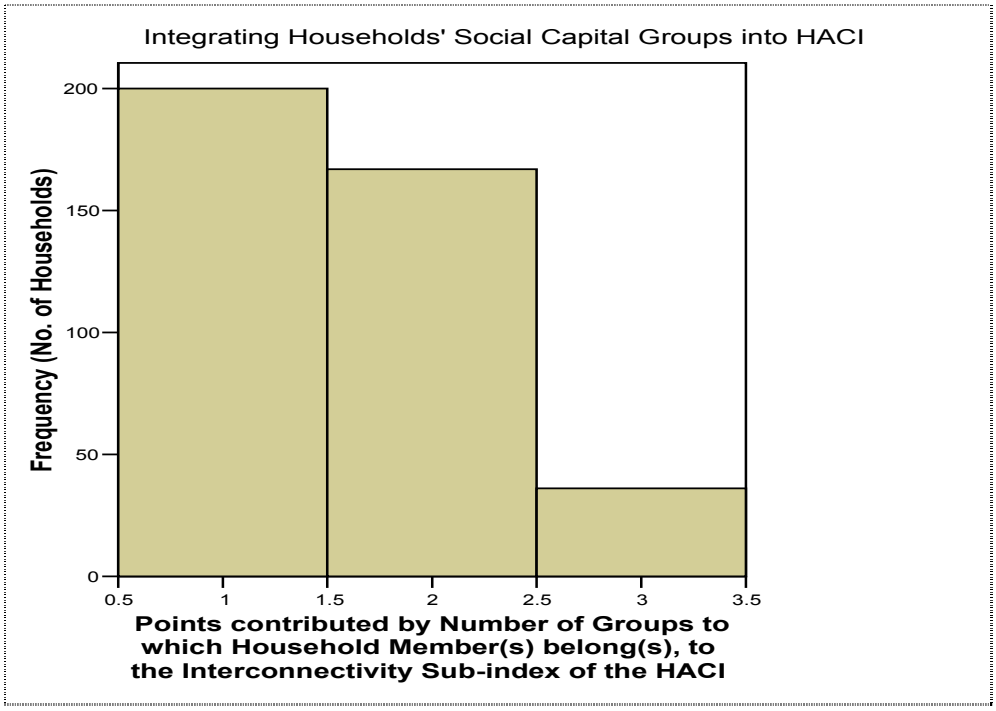
Number		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<2	200	49.6	49.6	49.6
	2 - 4	167	41.4	41.4	91.1
	5 - 7	36	8.9	8.9	100.0
	Total	403	100.0	100.0	

The measuring scale applied to this variable ensured that households with less than two groups were assigned a value of one, those with 2 – 4 groups had a value of two while the households with 5 – 7 groups had a value of three. In the following frequency distribution graphs (figure 24), it can be seen that 200 households (49.6 per cent as also visible in table 23) had less than two groups and this therefore meant that a contribution of one point came from this variable and got into the sub-index (interconnectivity to higher level processes). Slightly over 41 per cent had 2 – 4 groups therefore showing a contribution of two points while about 9 per cent had membership to 5 – 7 groups therefore displaying a contribution of three points to the sub-index (interconnectivity to higher level processes).

The types of groups to which household members belonged included rotating savings and credit associations, merry go rounds, church groups, neighbourhood groups, clan groups, micro-finance organisations, youth groups, women groups, workers' groups and producer cooperatives among others.

Figure 24: Bar Graphs on Number of Groups to which Household Member(s) Belong





c) Number of social categories a household relies on during shocks (level of diversification of social capital contacts)

The social diversity of a household's social capital contacts is just as important as the geographical diversity of social capital contacts and the quantity (absolute numbers) of social capital contacts (just presented). In situations or areas with high incidences of negative shocks, the more robust[35] the circle of social capital contacts, the better placed a household is to respond to negative changes. However, sample statistics showed that over 62 per cent of the respondents had a restricted circle of people on which they could rely when misfortune struck. Only 2.7 per cent had wide circles of social capital contacts (robust group of social capital contacts) as summarised in table 24 and figure 25. A great majority of households could only count on family members and neighbours in cases of negative shocks. This situation embodies the risk that, in cases of negative shocks affecting the whole family or neighbourhood, there would be no alternative source of assistance. In comparison the fewer households which were able to mention employers, business partners or public officers as part of their social contacts besides family and neighbours (more diverse and therefore more robust circles of contacts) would have some options left even in case of a negative shock affecting the whole family or neighbourhood.

Table 24: Level of Diversification in Households' Social Capital Contacts.

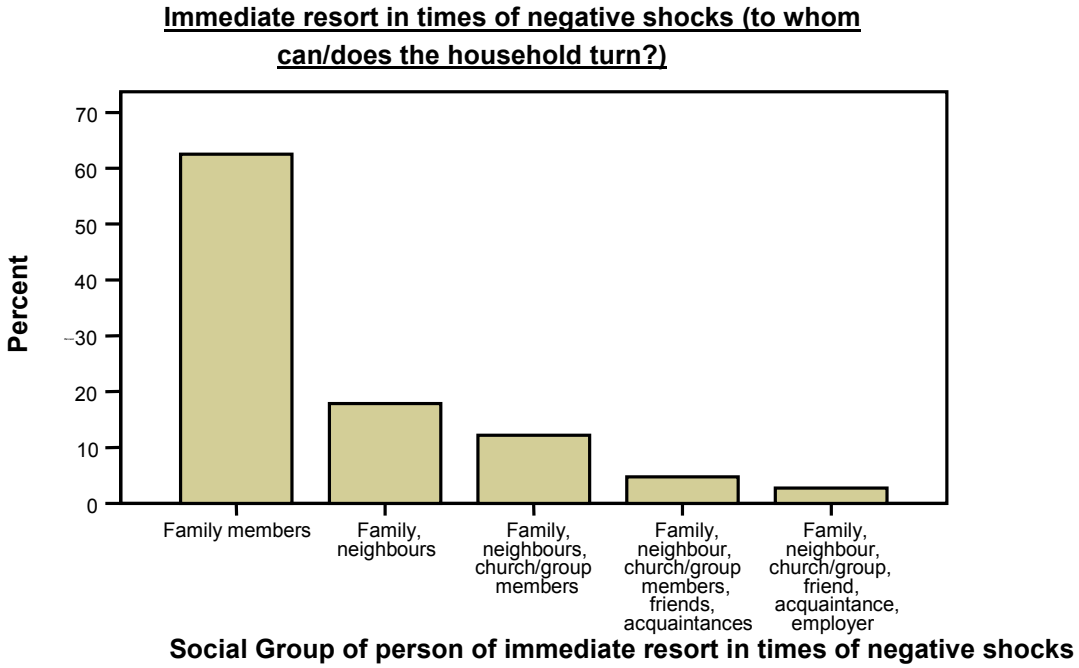
Immediate resort in times of negative shocks (to who can/does the household turn?)

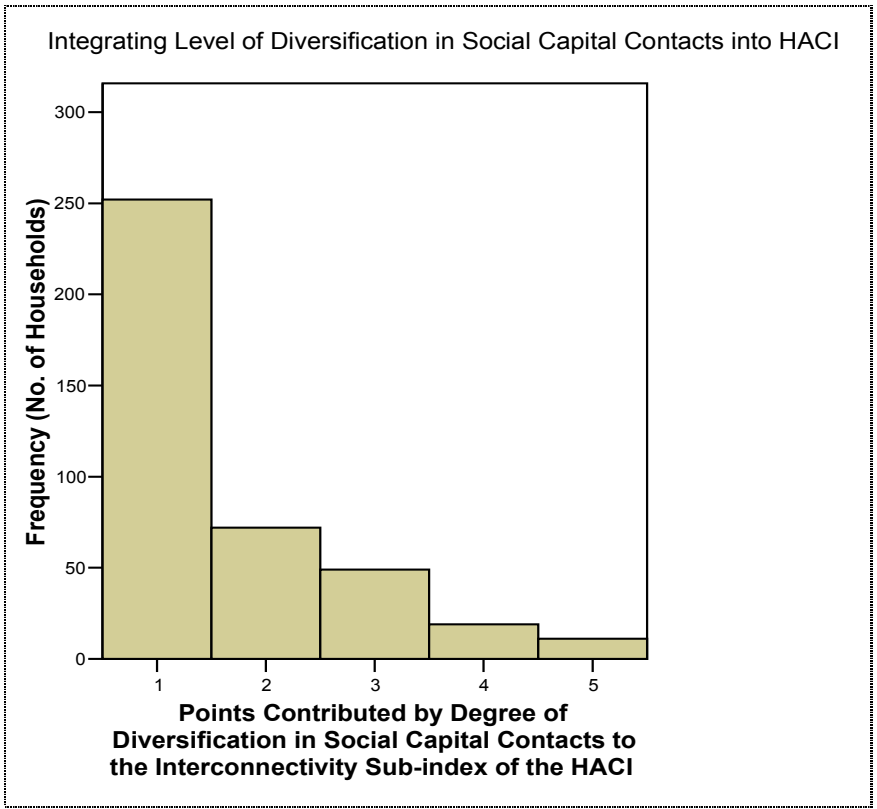
Social Group		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Family members	252	62.5	62.5	62.5
	Family,neighbours	72	17.9	17.9	80.4
	Family, neighbours, church/group members	49	12.2	12.2	92.6
	Family,neighbour,church/group members, friends, acquaintances	19	4.7	4.7	97.3
	Family,neighbour,church/group, friend, acquaintance, employer	11	2.7	2.7	100.0
	Total	403	100.0	100.0	

Households with only family members as reliable contacts in case of negative shocks had a contribution of 1 point to the sub-index (interconnectivity to higher level processes) while those with family and neighbours had a 2 point contribution. The presence of diversity - church group members and employer besides family, friends and neighbours was valued highly. The frequency graphs in figure 25 summarise the contribution of the level of diversity in social capital contacts to the sub-index (interconnectivity to higher level processes).

[35] Not simply consisting of family, friends and relatives but also employer, business partners, public officers, non-governmental organizations and others.

Figure 25: Bar Graphs on Level of Diversification in Households' Social Capital Contacts





The Composite Sub-index of Interconnectivity in higher level processes: By adding the contributions from the three variables (geographical scope of social capital contacts, number

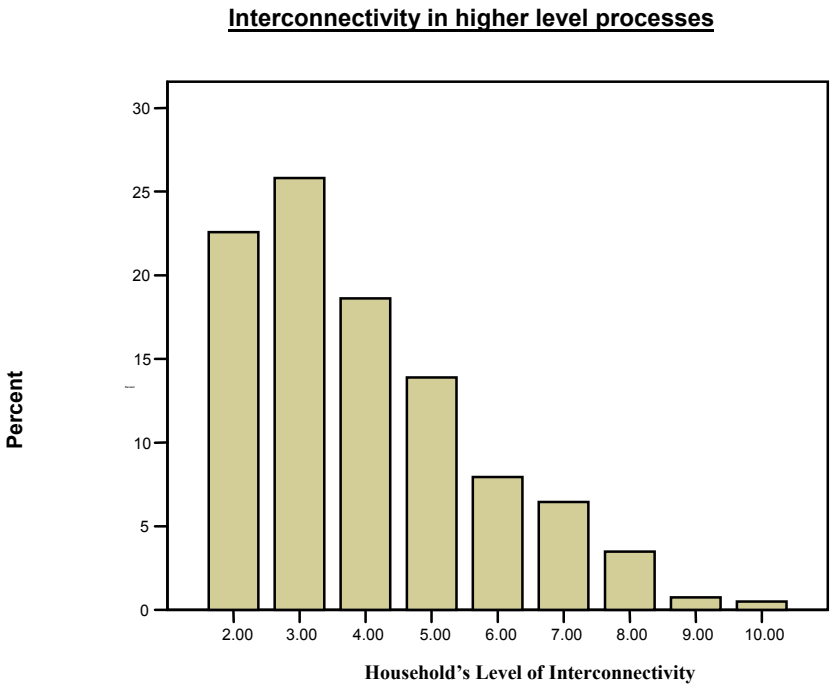
of groups to which at least a household member belongs and level of diversity in social capital contacts) of this sub-index, the values of this sub-index was obtained for each household. These values effectively constituted the contribution of the sub-index to the HACI. As may be seen in the following table and figures, for 67 per cent of the households, interconnectivity to higher level processes contributed 4 or less points to the HACIs of the concerned households.

Table 25: Statistics of Interconnectivity in Higher Level Processes

Interconnectivity in higher level processes

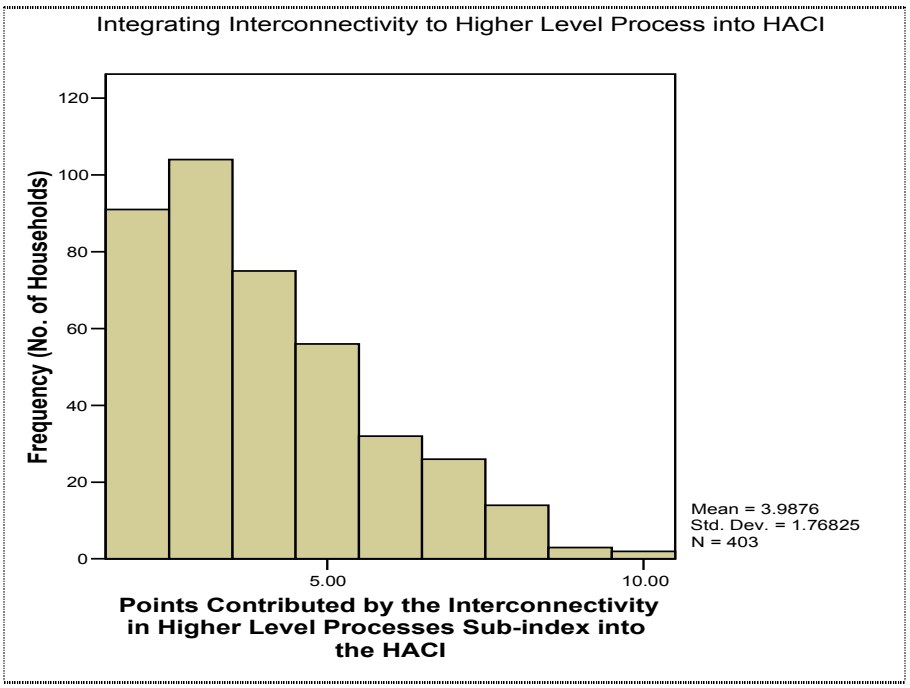
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	91	22.6	22.6	22.6
	3.00	104	25.8	25.8	48.4
	4.00	75	18.6	18.6	67.0
	5.00	56	13.9	13.9	80.9
	6.00	32	7.9	7.9	88.8
	7.00	26	6.5	6.5	95.3
	8.00	14	3.5	3.5	98.8
	9.00	3	.7	.7	99.5
	10.00	2	.5	.5	100.0
	Total	403	100.0	100.0	

Figure 26a: Bar Graph on Interconnectivity to Higher Level Processes



The contribution of this sub-index to the HACI is presented in figure 26b.

Figure 26b: Contribution of Interconnectivity to Higher Level Processes into HACI



5.14 Susceptibility to environmental changes

This sub-index captured the extent to which a household relies on threatened livelihood bases or resources which are highly prone to degradation. It had the following variables.

a) Contribution of farming to household livelihood

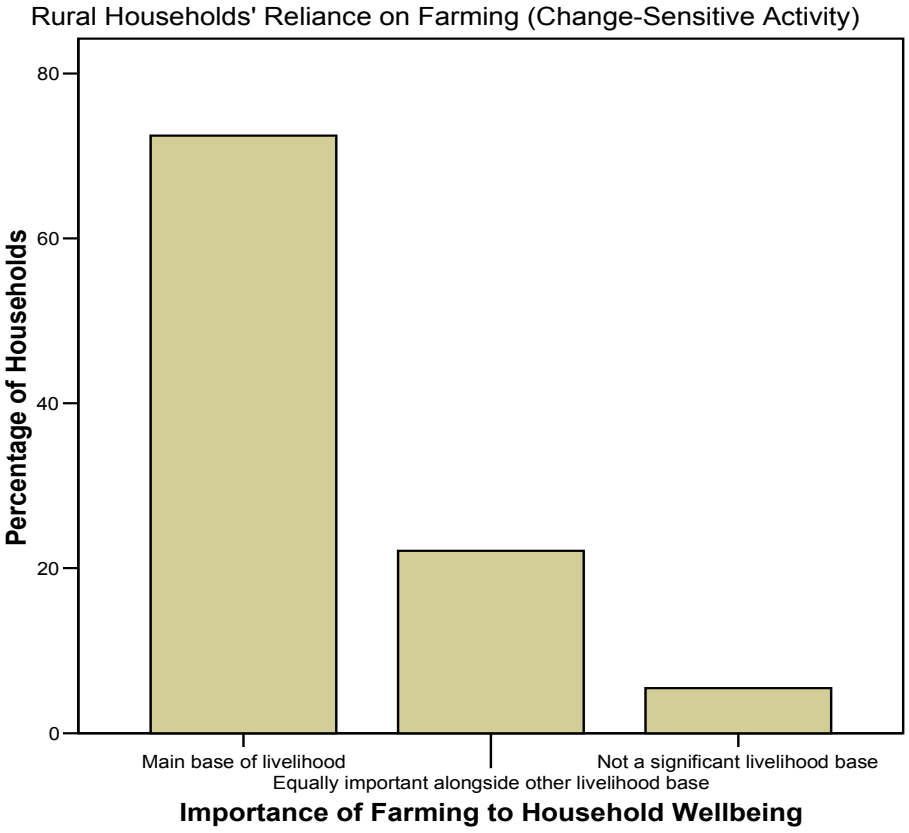
Nearly 73 per cent of the households in the sample heavily depended on farming (highly sensitive to environmental stress and climate variability) as the main base of livelihood. The relevant descriptive statistics for this variable are presented in the following table and figures.

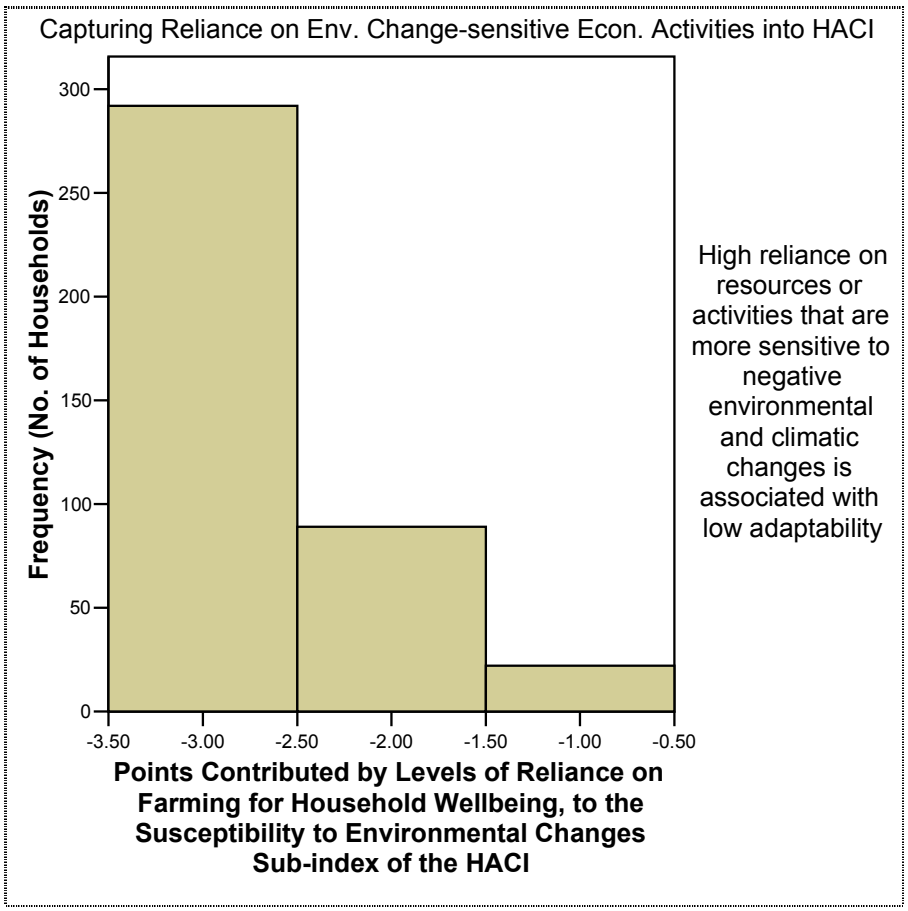
Table 26: Importance of Farming to Household Wellbeing

Contribution of farming to household wellbeing

Level of Significance of Farming		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Main base of livelihood	292	72.5	72.5	72.5
	Equally important alongside other livelihood base	89	22.1	22.1	94.5
	Less significant livelihood base	22	5.5	5.5	100.0
	Total	403	100.0	100.0	

Figure 27: Bar Graphs on Importance of Farming to Household Wellbeing





Given that farming tends to be more sensitive to negative environmental changes, the variable (Contribution of Farming to Household Wellbeing) had a contribution of -3 (negative three) to the sub-index (Susceptibility to Environmental Changes) in cases where farming was the main base of livelihood. Contributions of -2 (negative two) and -1 (negative one) were obtained in cases where farming was an equally significant base of livelihood alongside others and in cases where farming was of less significance respectively.

b) Cooking energy source

Even as the global temperature rises, species disappear and deforestation further intensifies environmental stress, over 94 per cent of the households in the sample exclusively used wood fuel as their source of cooking energy. A currently high level of use of sources of energy which are less sensitive to environmental changes is considered to be beneficial to household adaptive capacity since such households become less reliant on the increasingly scarce wood. As illustrated in the table 27 and figure 28, the share of alternative sources of energy in domestic use was very low in the area of study.

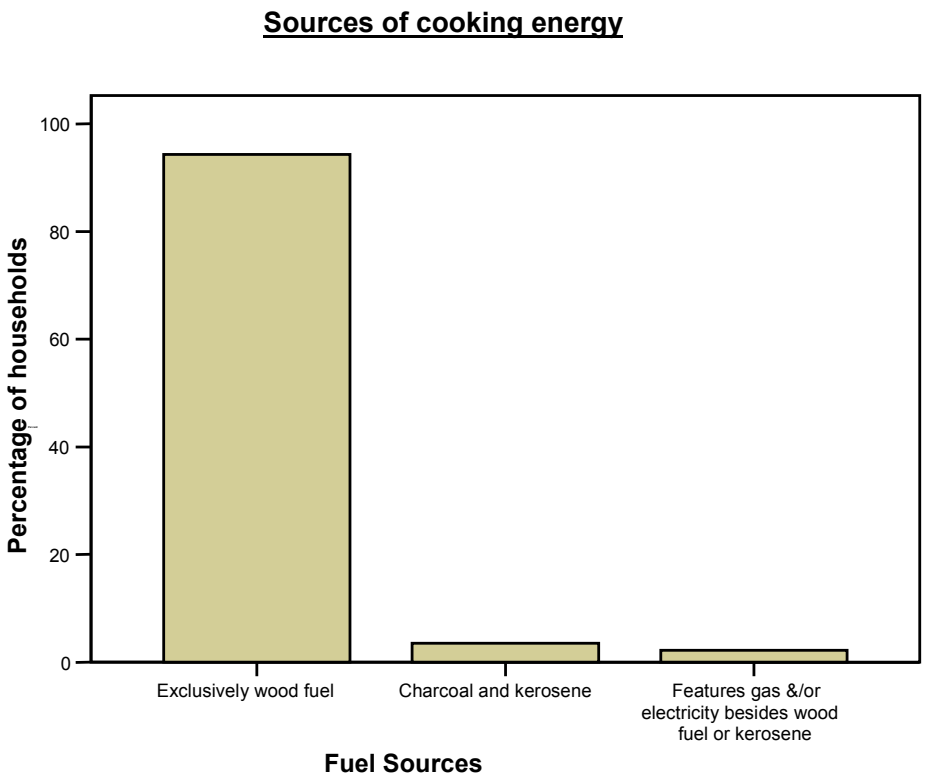
Table 27: Importance of Change-Sensitive Sources of Energy to Households

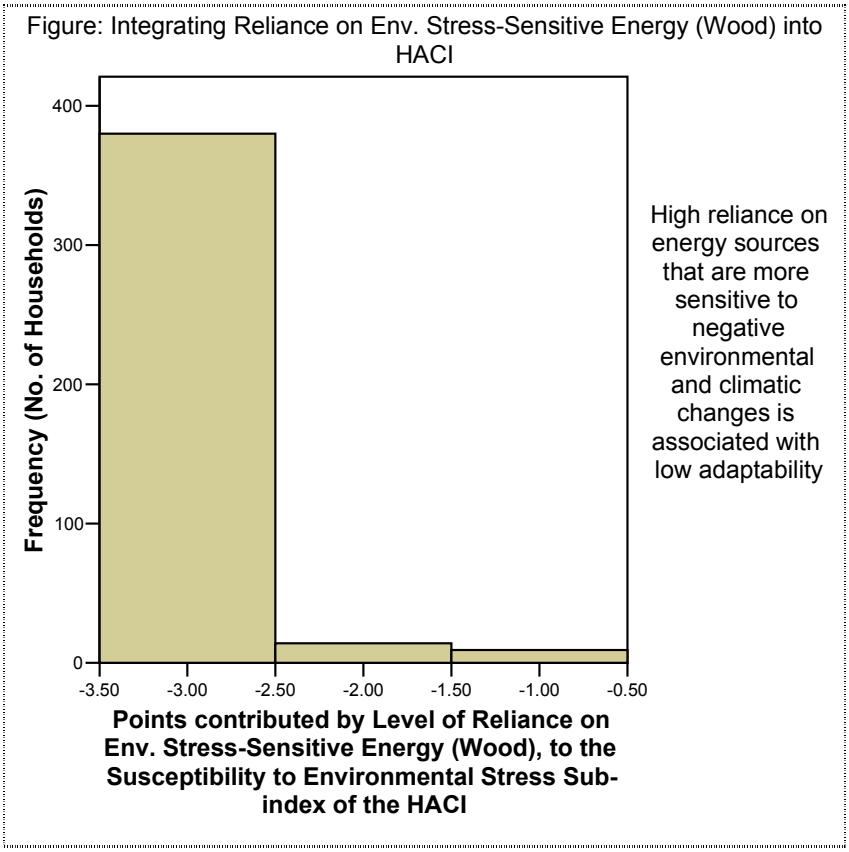
Sources of cooking energy

Fuel sources		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Exclusively wood fuel	380	94.3	94.3	94.3
	Charcoal and kerosene	14	3.5	3.5	97.8
	Features gas &/or electricity besides wood fuel or kerosene	9	2.2	2.2	100.0
	Total	403	100.0	100.0	

As can be seen, a very great majority of households in the area of study relied exclusively on wood fuel for cooking with the other sources of energy like kerosene, gas and electricity being used merely as minor complements (especially in urban settings). Most of the households obtained wood from the few remaining stocks of vegetation while others bought the same from local markets. Symptomatic of this heavy reliance on wood fuel was the fact that most respondents regretted that the introduction and stricter enforcement of fees for collection of wood from Kakamega forest was impacting their household budgets. As may be seen in figure 28, only 2.2 per cent of the households featured the use of cooking gas and/or electricity as complements for wood fuel. Even then, such alternative sources were only used occasionally.

Figure 28: Bar Graphs on Importance of Change-Sensitive Energy Sources





Having established why the reliance on environmentally sensitive sources of energy (wood) was viewed as a negative factor for household adaptability, a distinction was made between

the various degrees of reliance on wood. As graphically displayed in the frequency distribution, exclusive reliance on wood fuel had a negative contribution of -3 (negative three) to the sub-index (susceptibility to environmental changes) while the incorporation of other sources of energy like kerosene had a contribution of -2 (negative two) and the use of gas/electricity as further complements had a contribution of -1 (negative one).

c) Reliance on natural spring/stream water for domestic use.

A high level of reliance on sources of water that were more sensitive to environmental changes was viewed as a weakening factor for household adaptability. As may be seen in table 28 and figure 29, over 92 per cent relied on stream/spring water thereby presenting a higher level of exposure to the vagaries of environmental stress besides the dangers of ill-health from water-borne diseases.

Table 28: Importance of Change-Sensitive Water Sources

Main Source of domestic water for the household

Sources		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Spring/Stream/River	372	92.3	92.3	92.3
	Public pipe/Piped Water/Pipe in the house	31	7.7	7.7	100.0
	Total	403	100.0	100.0	

Figure 29: Bar Graph on Household Sources of Energy

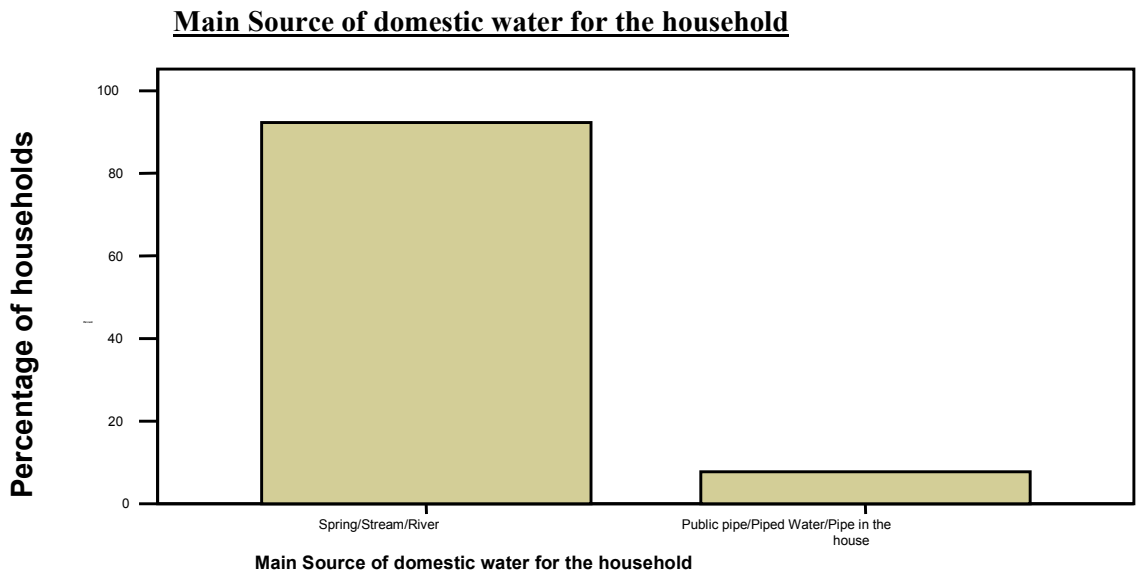
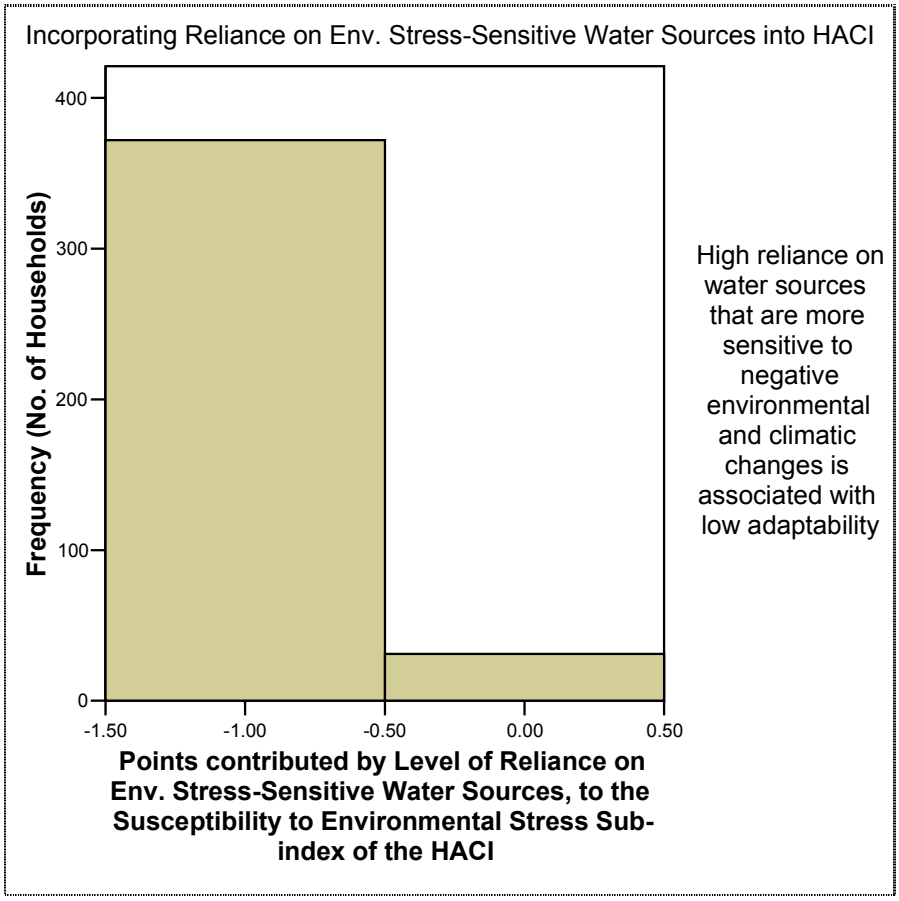


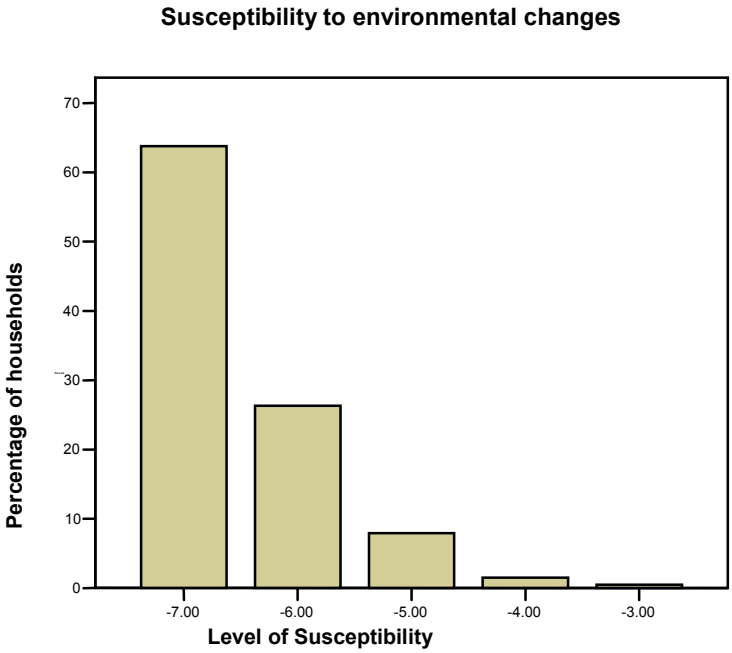
Figure 30: Capturing Level of Reliance on Change-Sensitive Water into HACI

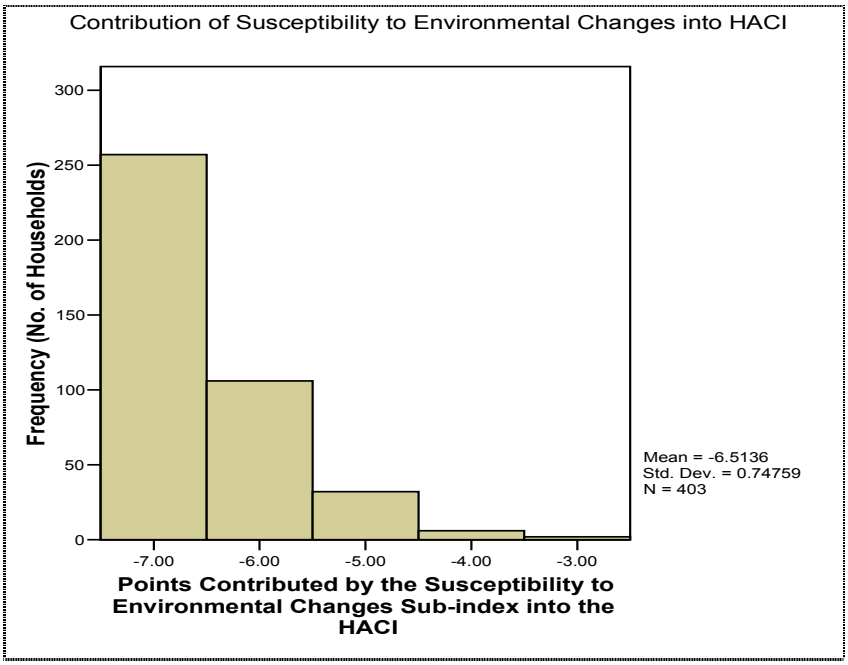


In cases where households relied on spring or stream water, this variable had a contribution of -1 (negative one) to the sub-index (Susceptibility to environmental changes) while the variable was neutral in cases where households had piped water (this can be seen in the just presented frequency distribution graph in figure 30).

The Composite Sub-index of Susceptibility to Environmental Changes: For each household, the aggregation of the contributions of the three variables (level of reliance on farming, source of energy and source of water) yielded the individual values of the susceptibility to environmental changes sub-index (also its contribution to the HACI). From the figure 31, it can be seen that more than 60 per cent of the households had negative effects on their HACIs reflected through 7 negative points arising out of their reliance on sources of livelihood, energy and/or water that were sensitive to environmental changes.

Figure 31: Bar Graphs on Integration of Susceptibility to Environmental Changes into HACI





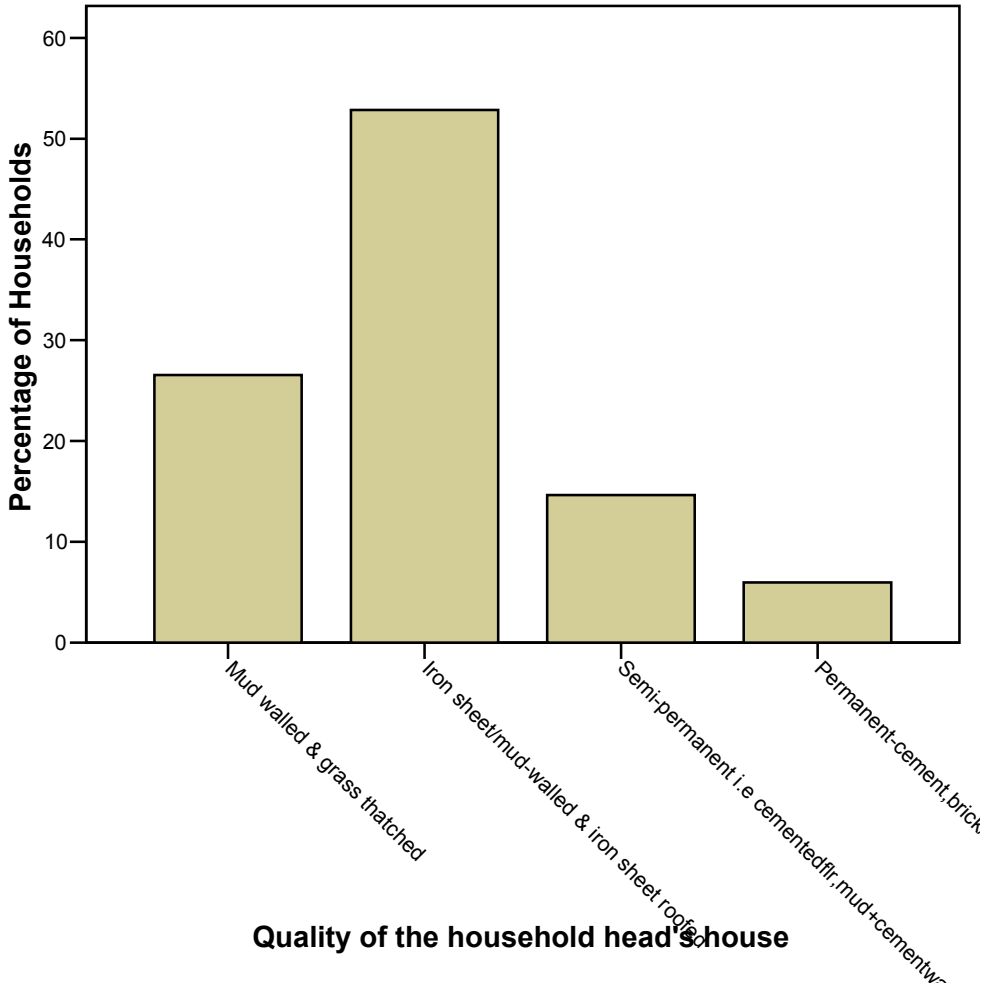
The just presented frequency distribution for the sub-index shows the number of households displaying various levels of negative contribution to the HACI due to their susceptibility.

5.15 Housing quality

The dwelling unit is often the first level of protection from the extremes of weather conditions and the housing situation (represented in this case by the quality of the household head's house). While assessing housing quality as a sub-index of the HACI, the following observations were made:

a) Quality of household head's house: Nearly 53 per cent of the houses or dwelling units were roofed with iron sheets and constructed with mud walls. The figure 32 and table 29 present a summary of the variable's descriptive statistics.

Figure 32: Statistics on Housing Quality



As may be seen in the above graphical presentation of the observations from the area of study, quality of housing was generally low. This information is presented in absolute terms in table 29 from where one can see that: Out of 403 households, 107 had mud-walled and grass

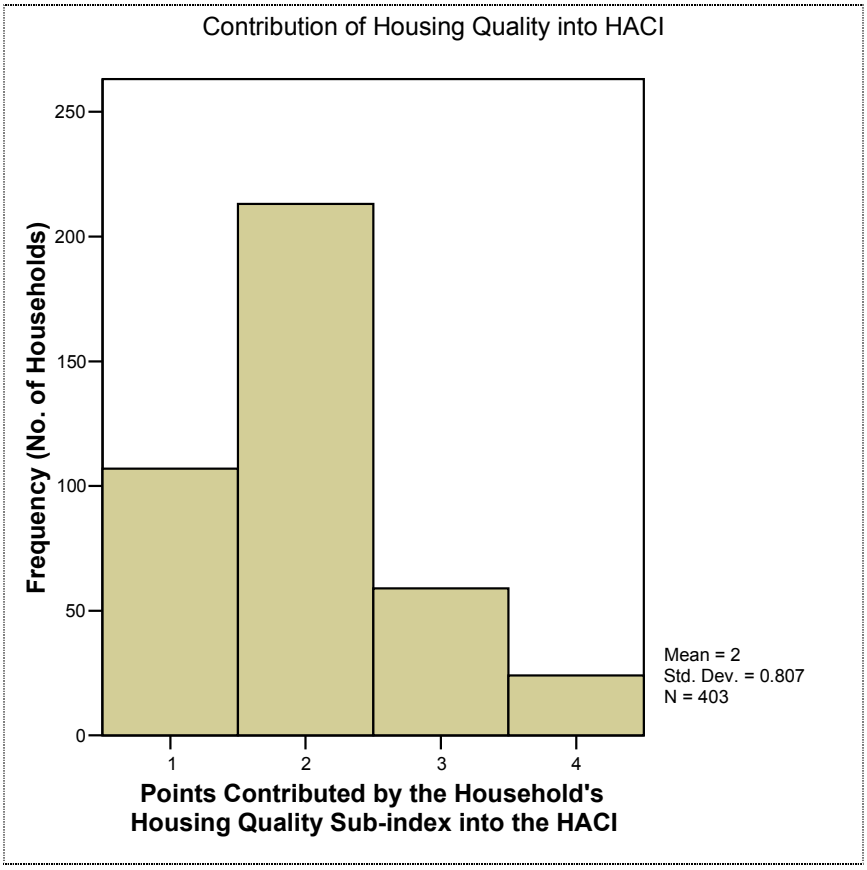
thatched dwelling units, 213 had mud-walled and iron-sheet roofed dwelling units while 59 and 24 had semi-permanent and permanent houses respectively.

Table 29: Observations on Household Housing

Type of household head's housing		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mud walled & grass thatched	107	26.6	26.6	26.6
	Iron sheet/mud-walled & iron sheet roofed	213	52.9	52.9	79.4
	Semi-permanent i.e. cementedflr,mud+cementwall,ironsheetroof	59	14.6	14.6	94.0
	Permanent-cement,brick/concrete/stone & ironsheets/tiles	24	6.0	6.0	100.0
	Total	403	100.0	100.0	

In the cases of households in which household heads were not homeless but had dwelling units made up of mud walls and grass thatch (26.6 per cent), this sub-index contributed 1 point to the HACI while for the 52.9 per cent of the households with household head's houses made up of iron sheet roofs and mud walls, this sub-index contributed 2 points to the HACI.

Figure 33: Integrating Quality of Housing into HACI



Other contributions were: 3 points for 14.6 per cent of the households (which had semi-permanent household heads' houses) and 4 points for 6 per cent of all the households in the sample (which had permanent household heads' houses).

5.16 Awareness level and actions taken

The following figures present the descriptive statistics on the levels of awareness of prevailing environmental stress issues and the actions taken against the same. The extent of knowledge of prevalent phenomena (which is a key prerequisite for effective adaptation) was captured through the assessment of the ability to describe prevalent environmental changes while the number of trees planted on household farms (in response to wood scarcity) was used as an indicator for the efforts taken in response to environmental stress.

a) Ability to describe prevalent environmental changes

A great majority (nearly 64 per cent) of the respondents were able to describe prevalent environmental changes as compared to 36 per cent who could not (refer to table 30).

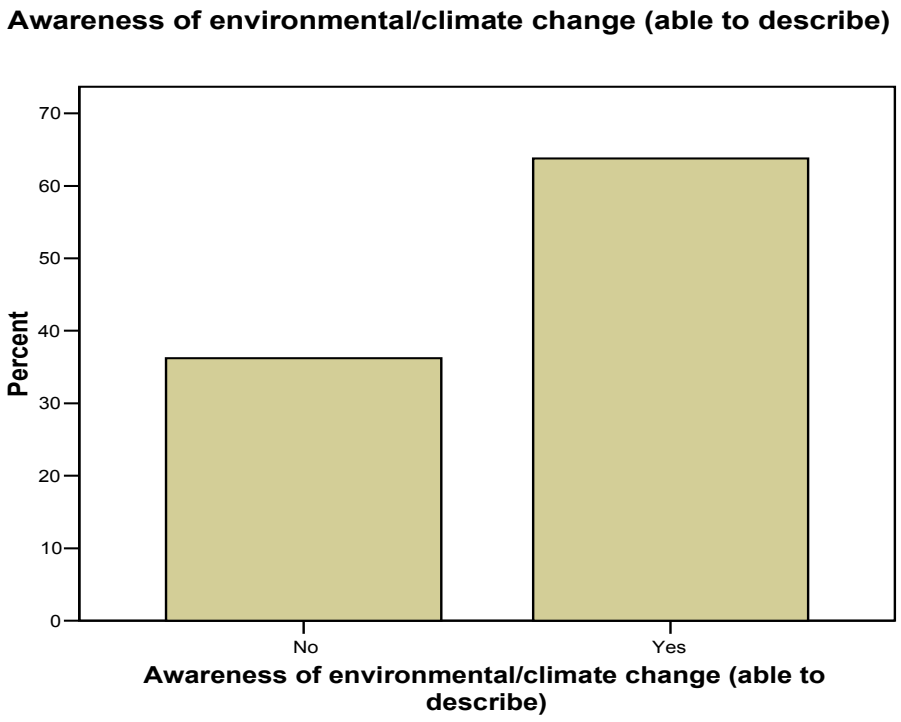
Table 30: Level of Awareness of Prevalent Environmental/Climatic Changes

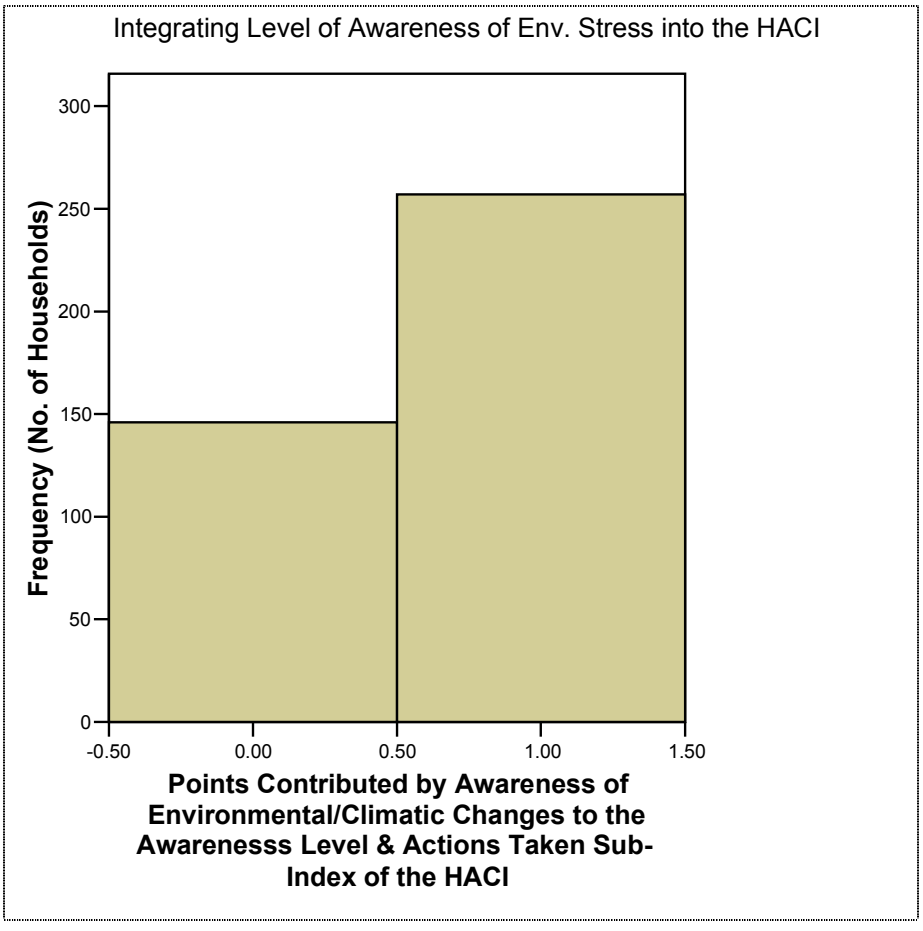
Response		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	146	36.2	36.2	36.2
	Yes	257	63.8	63.8	100.0
	Total	403	100.0	100.0	

Most of the information regarding prevalent environmental changes was gained from past experience/observations made by the respondents in the area of study. Impacts of such changes on livelihood through poor harvests or growing difficulty in finding firewood appeared to have become edged in the minds of respondents. The awareness-raising work by the government, non-governmental organisations, youth groups and other community based organisations were also reported to have played significant roles in informing the respondents of prevalent environmental changes.

In measuring this variable, a value of 1 was assigned in cases where respondents were capable of describing prevalent environmental changes while 0 (zero) was assigned in cases of inability to describe prevalent changes. This gave raise to contributions of points to the sub-index as summarised in the following frequency distribution graphs.

Figure 34: Bar Graphs on Level of Awareness of Prevalent Changes





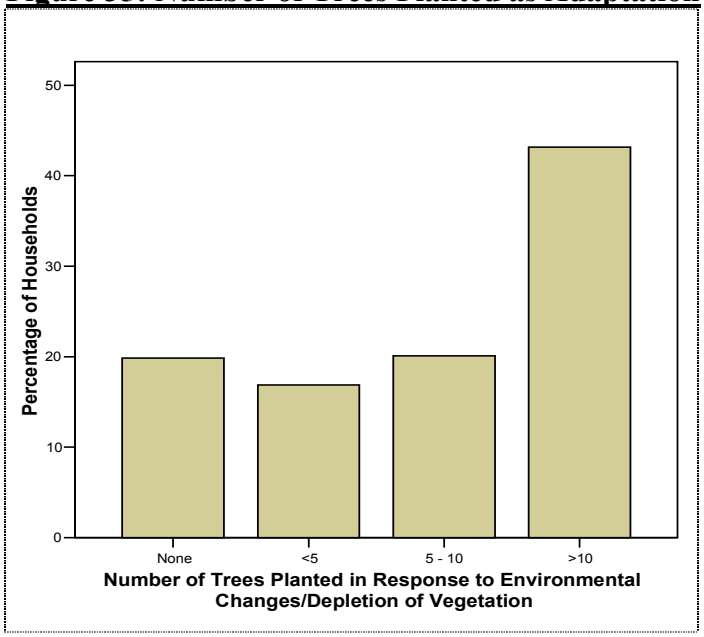
b) On-farm trees

Since soil degradation and deforestation were some of the most known challenges, on-farm cultivation of forest species was a popular response strategy. Less than 20 per cent of the households had not planted trees. However, the number of planted and growing trees varied greatly among the households. As may be seen in table 31 and in figures 35 and 36, nearly 17 per cent had less than five trees; slightly more than 20 per cent had 5 – 10 trees while 43 per cent had more than ten trees. Limited land in the face of a rapidly growing human population was mentioned as a key limiting factor in efforts to plant more trees.

Table 31: Number of Trees Planted in Response to Environmental Changes

Number of trees		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	80	19.9	19.9	19.9
	<5	68	16.9	16.9	36.7
	5 - 10	81	20.1	20.1	56.8
	>10	174	43.2	43.2	100.0
	Total	403	100.0	100.0	

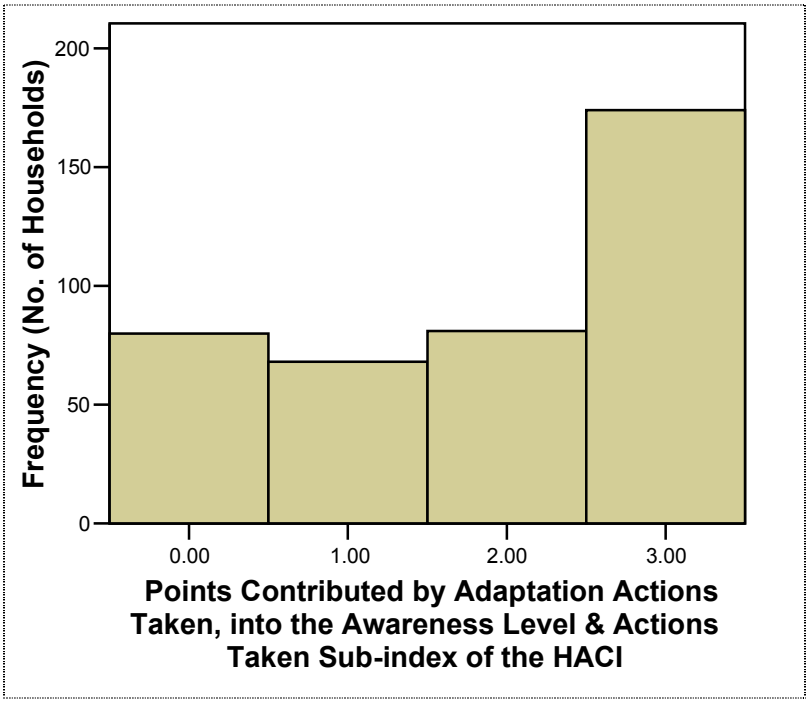
Figure 35: Number of Trees Planted as Adaptation



The measurement scale applied for this variable (actions taken against prevalent environmental changes) featured a value of 0 (zero) in cases of households which had taken no action (no planted trees), 1 (one) in cases of households that had planted fewer than five trees; 2 (two) in cases of households that had 5 – 10 trees and 3 (three) in cases of households that had more than ten trees. These values formed the basis of the contribution of the variable

to the sub-index (level of awareness and actions taken) and the further details of the contribution may be seen in figure 36.

Figure 36: Integrating Actions Taken Against Environmental Stress into HACI

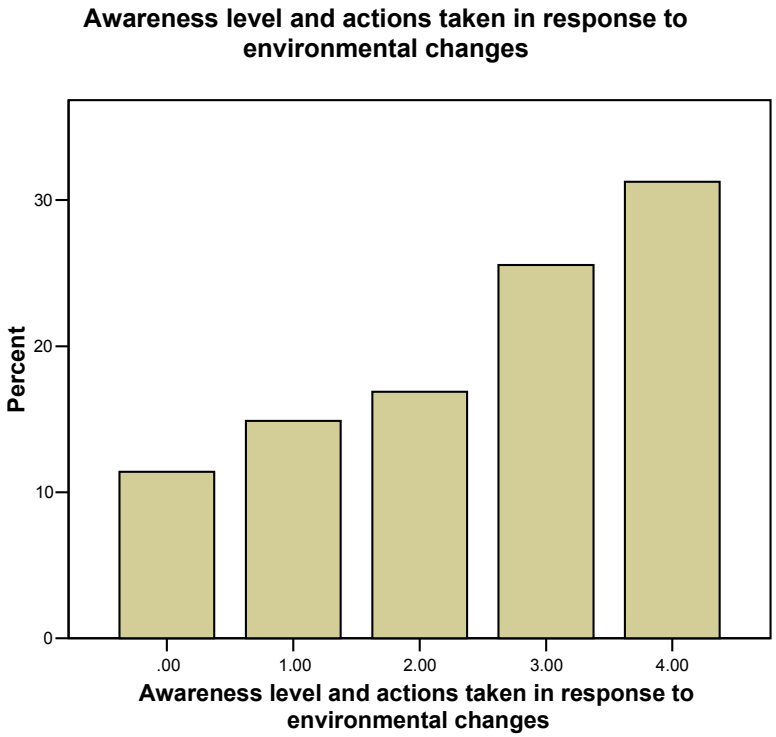


The Composite Sub-index of Awareness Level and Actions taken: Aggregating the contributions of the two variables (level of awareness of prevalent environmental changes and actions taken in response to environmental changes) yielded values of this sub-index. Nearly 64 per cent of the households were sufficiently aware of the prevalent environmental stress conditions and over 43 per cent had planted more than 10 trees on their farms. As a result, almost 69 per cent of the households had contributions of at least 3 points to their respective HACIs as may be seen in table 32 and figure 37.

Table 32: Contribution of Awareness Level and Actions Taken Sub-index into HACI

Value		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	46	11.4	11.4	11.4
	1.00	60	14.9	14.9	26.3
	2.00	68	16.9	16.9	43.2
	3.00	103	25.6	25.6	68.7
	4.00	126	31.3	31.3	100.0
	Total	403	100.0	100.0	

Figure 37: Bar Graphs on Contribution of Awareness Level & Actions Taken into HACI



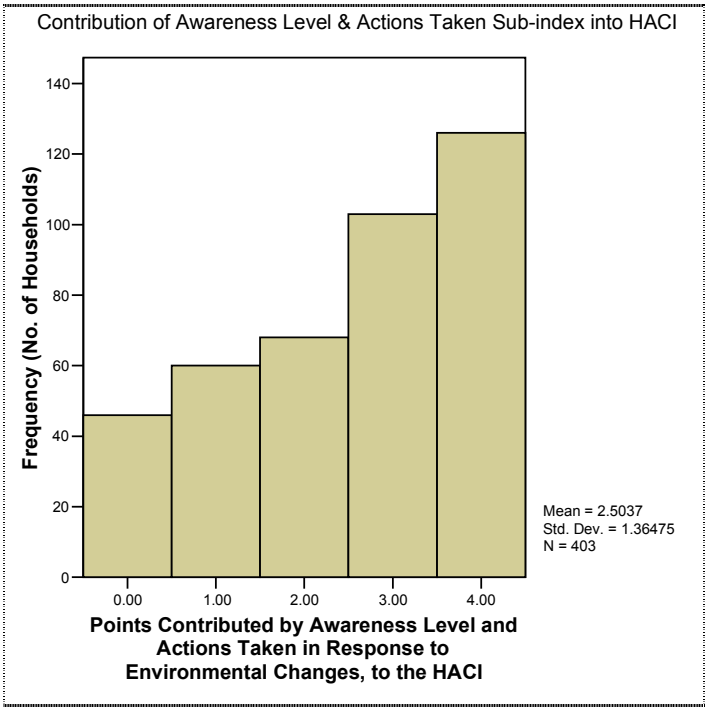


Figure 37 has presented percentages as well as absolute number of households against the possible values of the sub-index which in effect are its contribution to the HACI. It is now time to see the results of aggregation of all the six composite sub-indices whose results have just been presented.

HACI: Aggregating the contributions of the sub-indices (excluding the external sub-index), the HACI assumes values ranging from -1 to 27. As can be seen in table 33 and figure 38, a majority of the households had relatively low adaptive capacity indices with approximately 58 per cent displaying HACIs of 9 and below (mean = 9.64, mode = median = 9).

Table 33: Household Adaptive Capacity Index without External Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-1.00	1	.2	.2	.2
	.00	3	.7	.7	1.0
	1.00	4	1.0	1.0	2.0
	2.00	3	.7	.7	2.7
	3.00	6	1.5	1.5	4.2
	4.00	17	4.2	4.2	8.4
	5.00	26	6.5	6.5	14.9
	6.00	34	8.4	8.4	23.3
	7.00	47	11.7	11.7	35.0
	8.00	42	10.4	10.4	45.4
	9.00	50	12.4	12.4	57.8
	10.00	39	9.7	9.7	67.5
	11.00	23	5.7	5.7	73.2
	12.00	25	6.2	6.2	79.4
	13.00	19	4.7	4.7	84.1
	14.00	11	2.7	2.7	86.8
	15.00	10	2.5	2.5	89.3
	16.00	7	1.7	1.7	91.1
	17.00	5	1.2	1.2	92.3
	18.00	5	1.2	1.2	93.5
	19.00	4	1.0	1.0	94.5
	20.00	6	1.5	1.5	96.0
	21.00	6	1.5	1.5	97.5
	22.00	4	1.0	1.0	98.5
	23.00	1	.2	.2	98.8
	24.00	1	.2	.2	99.0
	25.00	1	.2	.2	99.3
	26.00	2	.5	.5	99.8
	27.00	1	.2	.2	100.0
	Total	403	100.0	100.0	

Source: Author's calculations

The distribution features households with low, medium and high HACIs. The HACI gives us an idea of how capable a household is to independently adjust to negative environmental changes. All factors remaining constant, the higher the HACI of a particular household, the higher its adaptability. A household with a HACI of 20 is likely to possess an adequate

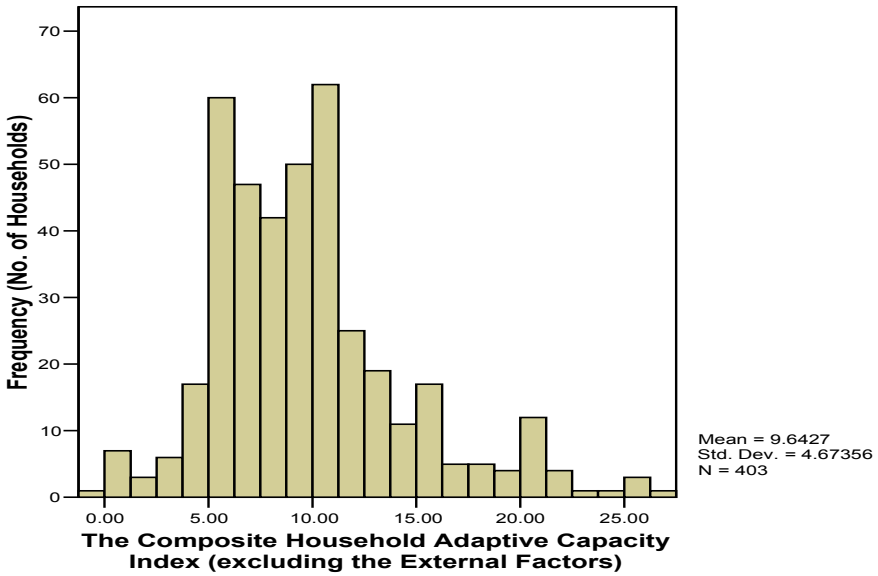
amount of assets, to be less dependent on environment-sensitive resources and to be taking more effective adaptation steps as compared to another one with a HACI of 8. However, since the HACI is a composite index two households with the same HACI (say 9), may feature different underlying characteristics. As may be seen from the following summary statistics, slightly over 62 per cent of the households had HACIs of 10 and below.

Statistics of the Household Adaptive Capacity Index

N	Valid	403
	Missing	0
Mean		9.6427
Median		9.0000
Mode		9.00
Range		28.00
Percentiles	12.5	5.0000
	25	7.0000
	37.5	8.0000
	50	9.0000
	62.5	10.0000
	75	12.0000
	87.5	15.0000

The whole sample yielded the HACI distribution presented in the histogram in figure 38.

Figure 38: Distribution of the HACI (Excluding the External Sub-Index)



To locate a threshold for sustainably high HACIs and help differentiate between households capable of independent adaptation and those at or below the transitional region a household asset line was used. Household assets were chosen as a basis for comparison due to the ability of assets to cushion households by generating income flows to deal with emerging shocks. In

the rural areas, earnings from the sales of farm produce or from employment is often used for the day-to-day running of the household and, if some is left (in few cases), savings. On the other hand, the income generated from assets (such as sale of livestock) often provides a cushion for households in cases of poor harvests, job losses, illnesses, death of a breadwinner or natural disaster. As was mentioned earlier, rural households often dispose off their assets in order of reducing permanence or value when a negative shock like illnesses or weather related crop failure strikes. As such, the cushioning effect obtained from assets may be said to be especially important for the adaptability of rural households, whose economic lives can be severely impacted by environmental stress and climate change.

In arriving at the minimum amount of total value of household assets which should be consistent with the threshold for sustainable adaptability, special focus was given to the ability of a household to secure basic human needs, education and health besides instituting adaptation. Considering the household sizes in the area of study (average headcount of 5 members), a critical basket of goods featuring food, shelter, clothing, health, education and energy was assembled and the annual cost thereof obtained. A factor of 10 per cent of the total annual cost of the critical basket of goods was then added to arrive at the minimum amount of annual income flows necessary for sustainable adaptation (for instance, by engaging in income diversification, investment in farm inputs or tree planting).

In the area of study field observations revealed that an average household with at least a member attending secondary school, featured a total monthly budget of KES 5,625 composed of monthly food consumption out of own produce, monthly expenditure on food items purchased from external sources and monthly expenditure on non-food items like education, transportation and health services. This translated to KES 67,500 per annum and KES 75,000 after a factor of 10 per cent was added. It was thus estimated that, in order to adapt to the prevailing negative environmental changes at the time of the study, a household's assets (including capital goods such as land, livestock, bicycles, ox ploughs, flour mills, cars and motorcycles needed to generate at least KES 75,000 per annum).

Considering local factors like farm yield per acre, return on common investment like motorcycle taxi and mean wages, the proximate aggregate market value of assets that could

generate such an amount of income at the time of the study, was found to be KES 300, 000[36]. This exercise helped to answer such questions as: What HACI forms the threshold for independent adaptation? Below which HACI is external assistance in adaptation vital/mandatory? Which households feature transitory vulnerability? This calculated minimum asset base was sufficient to enable the households in question to afford basic needs, access education and health care while gradually adapting to the prevalent environmental changes through various strategies some of which featured income diversification, farm input use, tree planting and/or business investment. Assessing the data obtained from the area of study, this minimum amount of total household assets was observed among households with HACIs of 15[37] and above[38].

Having established a threshold for sustainable adaptation, this dissertation makes the following observations from an assessment of the group of households with the minimum threshold (HACI of 15 or higher): This group of households featured a high level of attainment of secondary school and above level of education (56 per cent had household heads with at least secondary school complete level of education), their members were in good health (83 per cent of the households featured no long term illnesses), most of them owned about 3 acres of land, they had diversified income sources (over 92 per cent had two or more significant income sources) yielding meaningful returns by local standards, most of them had planted more than ten trees as an adaptation measure (over 79 per cent had planted more than 10 trees) and a great majority (over 94 per cent) of them regularly used farm inputs. A simple majority of these households were headed by males, about 85 per cent of households in this group had 3 or less dependants (calculated by use of adult equivalents) and about 38 per cent were represented in 5 or more groups. Additional information has been summarized in table 34.

[36] As explained elsewhere in this dissertation, the common elements in household asset mixes were land, bicycles, motorcycles and oxen plough. During the research period, data from the Kenya Forest Service showed that Kenyans growing tea could earn KES 50, 000, while maize fetched between KES 40,000 - 77,100 per hectare (1 hectare = 2.47 acres, 1 acre = 0.4047. In optimal circumstances, households grossly earned around KES 42,000 per acre per year, a motorcycle taxi grossly brought in KES 93,600 per annum while a bicycle taxi grossly brought in KES 31,200 per annum.

[37] It is worth noting that a few of the households with a HACI of 15 and above had a total value of assets lower than the KES 300,000 asset line but still attained the threshold due to the positive contribution of other sub-indices.

[38] During the study, the respondents (mostly household heads) were asked if their households were in a position to independently adapt to prevalent environmental changes. A few answered in the affirmative while many said that they lacked the requisite adaptive capacity. The author closely examined the characteristics of those households who had answered in the affirmative and looked at the strategies adopted by the same versus the ones of those who reported to be incapable of independent adaptation. Special focus was laid on the mean levels of income of the two main groups. In the process of analysis, a third small but significant group of households stood out in the middle of the two main ones. The author then identified the HACI consistent with the mean levels of income from each of these three groups of households to attain a rough categorization of households into: those who had the requisite household adaptive capacity, those who were on the verge of attaining the threshold (transitional zone) and those who could not independently attain the requisite household adaptive capacity.

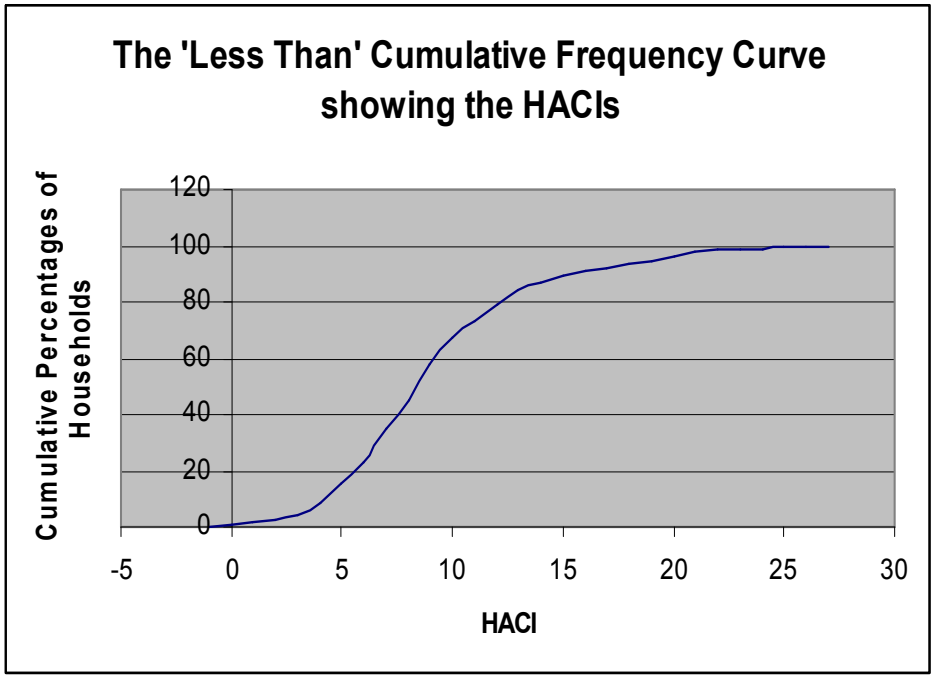
Table 34: Characteristics of Households with Threshold HACI Needed for Adaptation

Household Characteristic (a total 53 households attained the threshold)		Frequency	Per centage
Household literacy levels (% of read & write members)	Medium: 50 - 75	7	13.2
	High: > 75	46	86.8
Number of household members with sec. Complete education	0	7	13.2
	1	13	24.5
	2	16	30.2
	3	9	17
	4	8	15.1
Household size (headcount)	3	4	7.5
	4	1	1.9
	5	16	30.2
	6	11	20.8
	7	4	7.5
	8	10	18.9
	9	4	7.5
	10	1	1.9
	11	1	1.9
	13	1	1.9
Household size (adult equivalents)	Less than 3	5	9.4
	3 - =<6	40	75.5
	7 - <10	8	15.1
Number of household members with terminal illnesses	0	44	83
	1	8	15.1
	2	1	1.9
Highest level of education attained by household head	No formal schooling	2	3.8
	Primary complete	7	13.2
	Primary incomplete	10	18.9
	Secondary incomplete	4	7.5
	Secondary complete	21	39.6
	Vocational training	6	11.3
	Tertiary college	3	5.7
Main occupation of household head	Farmer	33	62.3
	Employee	18	34
	Non-agric. Self employment	2	3.8
Contribution of farming to household wellbeing	Main base of livelihood	26	49.1
	Equally important	25	47.2
	Less significant	2	3.8
Number of significant sources of income	1	4	7.5
	2	18	34
	3	23	43.4
	More than 3	8	15.1
Adaptation action taken	Tree planting	40	75.5
	Diversification	6	11.3
Number of trees planted as adaptation	Less than 5	2	3.8
	5 to 10	9	17
	More than 10	42	79.2
Using improved seeds	Yes	46	86.8
	No	7	13.2
Using inorganic fertilizers	Yes	50	94.3
	No	3	5.7

Some of the research observations described above are similar to the findings of Muyanga *et al* (2010) relating to household asset and poverty situations. The authors reported that consistently better-off households were more likely to: (i) have been male headed; (ii) have members with secondary and/or post-secondary educations; (iii) not be polygamous; and (iv) receive significantly more land and other assets at the time the household was formed. They were also less affected by mortality in the family. The authors added that the consistently better-off households owned more land and applied more organic and inorganic fertilizer than either the ascenders (those with improved livelihood bases) or descenders (those with weakened livelihood bases) even though they were no more likely to receive agricultural credit or grow major cash crops than the descenders.

Going by the threshold HACI of 15 which is consistent with the asset line of KES 300,000, it may be seen from figure 39 ('less than cumulative frequency curve[39]' or ogive/S-curve) that approximately 87 per cent of the households had HACIs below this threshold. This implies that only 13 per cent of the households had sufficient adaptive capacities for long-term (sustainable) adaptation. For the above-threshold group, the median value of household assets was KES 345,300.

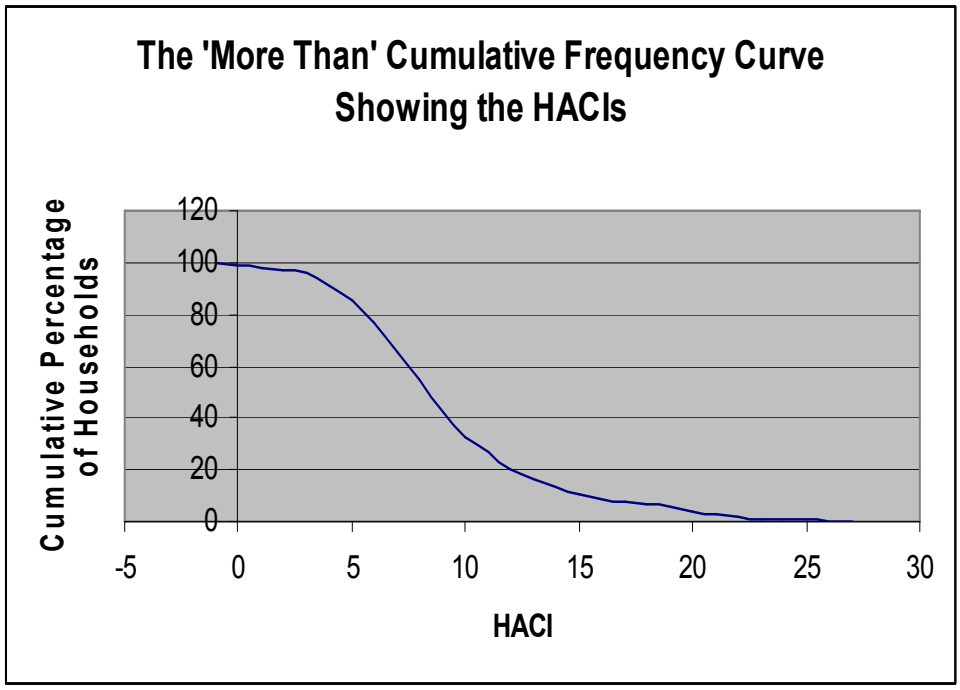
Figure 39: Ogive of the HACI (Excluding the External Sub-Index)



[39] Like the name suggests, the curve shows the percentage of observations below a given figure. It is readable by drawing a vertical line from the x-axis (say starting at a HACI of 15) to the curve and then drawing a horizontal one from the point at which the vertical line touches the curve, towards the y-axis and finally taking the reading.

Further assessment of the data revealed that households with HACI's ranging from 10 – 14 were likely to be in the transitional region with some experiencing transitory vulnerability at the time of the study. Factors responsible for transitory vulnerability included negative shocks like stock theft and morbidity. The households in transitory vulnerability displayed a potential for recovery over time and therefore may be deemed capable of assuming a sustainable path towards long-term adaptation sooner or later *ceteris paribus*. Positive shocks, substantial remittances or appropriate public support could ensure that the households in the transitional region pass the threshold sooner than otherwise while an increased incidence or intensity of negative shocks or longer-lasting negative phenomena could make such households sink below a HACI of 10 (below transitional region). Nearly a third (29.68 per cent) of all the households in the sample lay in this transitional region.

Figure 40: 'More Than' Cumulative Frequency Curve of the HACI (Excluding the External Sub-Index)

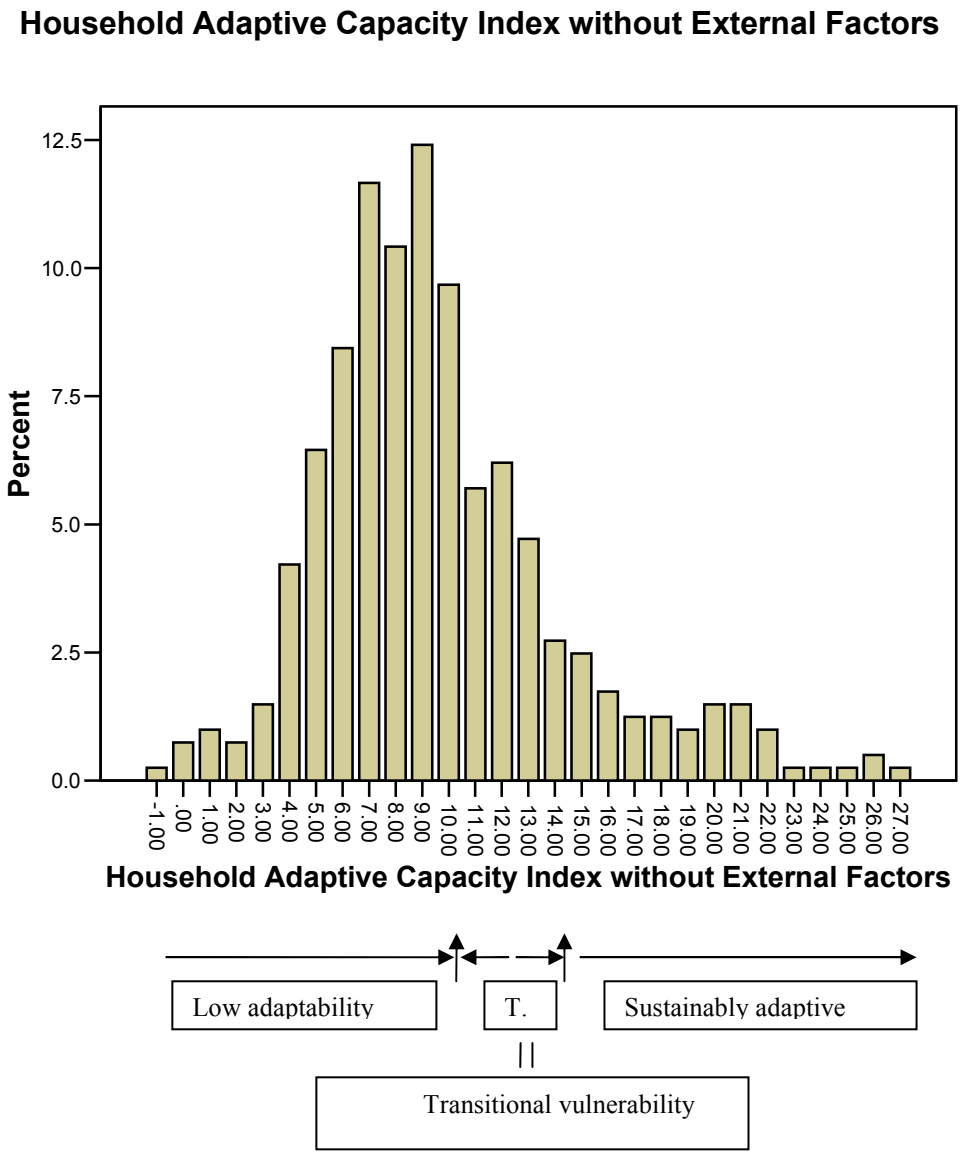


Whereas it has been shown that slightly more than an eighth of all the households lay beyond the threshold HACI of 15, it may be seen from the 'more than cumulative frequency curve[40]' shown in figure 40 that barely 38 per cent of the households had HACIs of 10 and above. This leaves more than 62 per cent not only below the threshold of 15 but also below the

[40] Like the name suggests, the more-than cumulative frequency curve shows the percentage of observations beyond a given figure. It is readable by drawing a vertical line from the x-axis (say starting at a HACI of 10) to the curve and then drawing a horizontal one from the point at which the vertical line touches the curve, towards the y-axis and finally taking the reading.

transitional vulnerability region of 10 - 14 (further illustration is provided in figure 41). In short, over 60 per cent of all the households in Kakamega district exhibited very low adaptive capacities and were highly unlikely to overcome their vulnerability to the prevailing negative environmental and climatic changes *ceteris paribus*.

Figure 41: Graphical Illustration of Threshold HACI and Transitional Vulnerability



Among other things, the households with low HACIs (below the transitional vulnerability region) had much fewer assets, relied more on resources which were sensitive to environmental stress, had much lower yields from farming activities partly due to sub-optimal use of farm inputs in face of degraded soils and had poor education profiles besides being

involved in low return social capital activities. The bottom eighth group of households indeed appeared to be at a serious risk of destitution in the foreseeable future barring external intervention. A brief comparison of the bottom and top eighth sections of the sample revealed differences along the lines tabulated in table 35.

Table 35: Comparison of the Bottom and Top Eighths of the Whole Sample

Aspect	Sub-sample	
	Bottom 8th	Top 8th
Huts as main dwelling units	25 %	3.8 %
Farming as main occupation	80 %	62.3 %
	Low value farming; fewer inputs	High value farming; adequate inputs
Total illiteracy in the household	20 %	0 %
Household has taken a loan	16.7 %	32 %
Realised average to full mitigation	18 %	62 %
Awareness of environmental changes	28.3 %	83 %
No reliable contacts to help in emergency	73.3 %	13 %
Membership to one or no group at all	71.7 %	11.3 %
Mean annual remittances (KES)	1,964	28,658
Farming as main livelihood source (KES)	93.3 %	49.1 %
Average value of capital goods (KES)	94,323	444,107
Tea growing	1.7 %	24.5 %
Sugarcane growing	0 %	7.5 %

In contrast to the top eighth group of households which had relatively high HACIs and which were characterized by regular savings, income diversification, asset accumulation, better education, higher values of remittances, lower dependency burden, use of improved seeds and breeds, business undertakings, loan taking, group memberships and lower morbidity (negative shocks), the bottom eighth group showed serious deficiency of these things. Kelly & Adger (2000), postulated poverty as a proxy for marginalisation and espoused that marginalisation translates to vulnerability through the narrowing of coping and resistance strategies. This dissertation finds a consistent phenomenon in that households with low adaptive capacities were also some of the poorest. Even though not all vulnerable people in the area of study were poor, nearly all poor people were vulnerable.

5.17 Relationships between the HACI and Some of its Sub-indices and Variables

Using the respondents' own assessment of the effectiveness of actions taken by their households in the face of negative environmental changes (environmental stress) and climate variability as a proxy for adaptive capacity, this section presents some observations that tend to support the choice of the sub-indices of the HACI which were identified and used in this

dissertation. For ease of explanation in the following discussion, adaptive capacity is assumed to have been enhanced in cases where respondents reported that the strategies they adopted had been effective in delivery solutions to their challenges.

Household Economic Wellbeing & Stability and Actions Taken: The role of assets in the adaptability of households seems to be underscored by the low number of high-asset-value[41] households whose actions against environmental problems recorded a less-than-average level of effectiveness. On the other hand, the observations show a proportionately low number of low-asset-value[42] households whose actions recorded above average levels of effectiveness. This situation is likely to owe its existence to the fact that asset ownership directly supports adaptability enhancing actions like income diversification even the direction of causality was not expressly established. Related to this, Michuki (2007) assessed income diversification in the same area and found out that relatively poorer households tended to diversify into low-return non-agricultural activities while the non-poor ones diversified into high-return non agricultural activities.

The summarised statistics are provided in table 36. Among other things visible in the table is the fact that out of the 29 households that had the highest values of assets, 25 (86 per cent) assessed the results of their adaptation and mitigation actions as having yielded average or excellent results (near full mitigation). On the other hand, 134 (89 per cent) out of the 151 households which had the lowest value of assets rated the results of their adaptation/mitigation actions as having delivered below average results.

[41] Similar observations were made by Muyanga *et al* (2010) relating to poverty in Kenya. The authors observed that households successfully accumulating assets and rising out of poverty (i) were more likely to have remained **healthy** and suffered **no** unexpected **deaths** during the decade prior to the start of the initial survey in 1997; (ii) were **less** adversely affected by **mortality** that did occur during the panel period compared to other households; (iii) were consistently headed by a male; (iv) received relatively **more land** from their parents at the time the household was formed; and (v) had **parents** who were relatively well-off and **educated**. Moreover, the ascenders (households with improved livelihood bases) were able to **acquire more land**, cultivate 70 per cent more land, and **increase** their use of **fertilizer** over the 2000 -2007 period.

[42] The observations of Muyanga *et al* (2010) in Kenya showed that households with declining asset trajectories were also more likely to have turned from male to female-headed due to male mortality, have two or more wives in the household, poorly educated household heads, have fathers or **household heads** who were relatively **uneducated**, and have relatively **little land** and other **assets** inherited from parents. The descenders (households with weakened livelihood bases) also tended to lose land and animal assets over the panel period (in some cases due to disease and the need to pay for medical expenses) in sharp contrast to the ascenders.

This kind of observation serves to support the central role of household economic wellbeing and stability (as measured by asset value and the other indicators) in determining adaptive capacity. Field observations revealed that the assets held were disposed off in order of reducing permanence to provide relief when negative shocks occurred or bridge budgetary gaps.

Table 36: Cross Tabulation - Value of Assets * Effectiveness of Adaptation Actions

		Effectiveness of actions taken against environmental problems					Total
		Ineffective	Almost ineffective	Average	Almost full mitigation	Full mitigation	
Category of total monetary value of moveable and non-moveable assets/goods	<150000	65	39	39	8	0	151
	150000 - <250000	27	38	68	14	0	147
	250000 - <350000	6	12	31	6	4	59
	350000 - <450000	1	1	3	6	0	11
	450000 and above	4	0	12	6	7	29
Total		103	90	153	40	11	397

It is however important to mention that, apart from the quality and quantity of assets, the asset type (whether productive or otherwise) is also important. Furthermore, the act of using the household assets to achieve income diversification potentially accounts for a significant portion of inter-household differences in adaptability. Two households may own the same types and value of assets but exhibit different levels of success seen by profitably in using the assets.

Income diversification and satisfaction with mitigating/adaptation actions: Most of the households which claimed to have attained full mitigation, had diversified incomes.

Table 37: Cross tabulation - Effectiveness of Adaptation Actions * Income Diversification

		Number of significant (at least 20% contribution to total income) sources of household income				
		One	Two	Three	More than three	Total
Effectiveness of actions taken against environmental problems	Ineffective	54	47	2	0	103
	Almost ineffective	28	54	6	2	90
	Average	42	91	16	4	153
	Almost full mitigation	4	20	12	4	40
	Full mitigation	0	2	7	2	11
Total		128	214	43	12	397

Out of the eleven households which reported either having attained full mitigation or almost having attained full mitigation of environmental-stress-related challenges that had affected them, seven had three different significant sources of income (summary in table 37). Furthermore, it can be seen in table 38 that 22 per cent of all the households in the sample had HACIs of 9 and below and had only one source of income. By contrast, only 4 households which had HACIs of 15 and above relied on one source of income (in total, 53 households had HACIs of 15 and above).

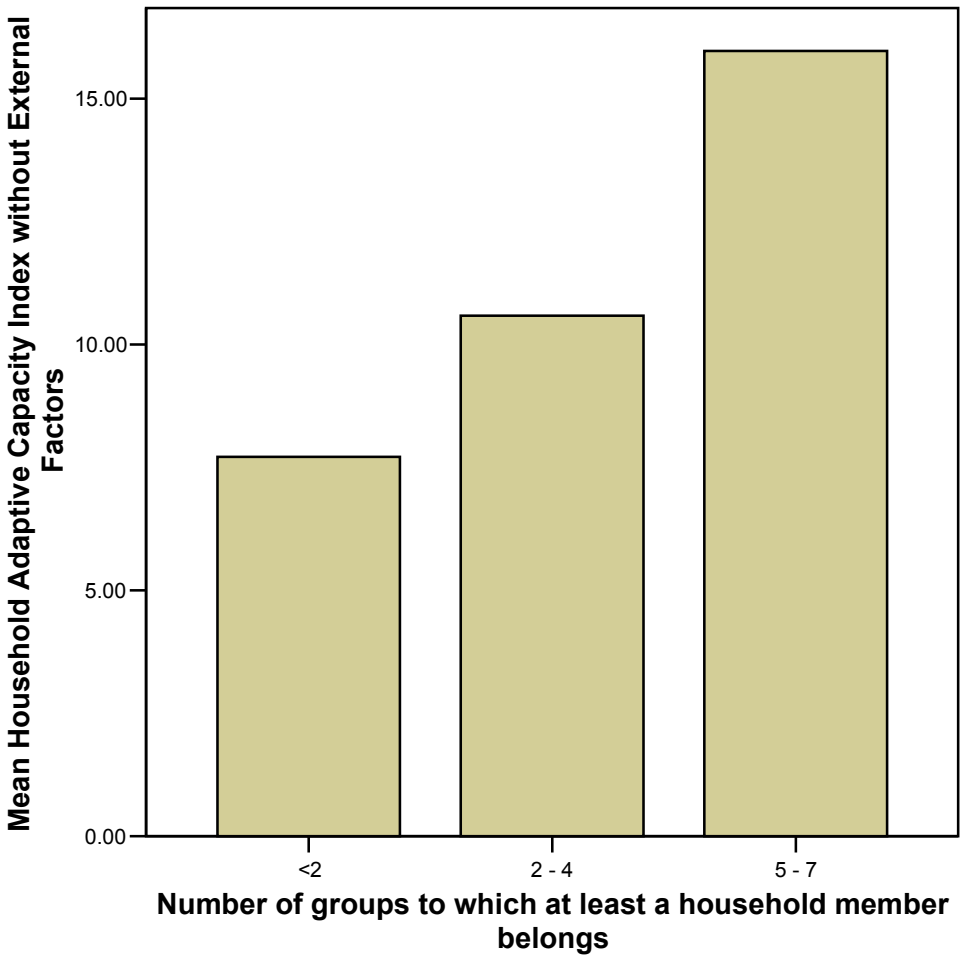
Table 38: Cross Tabulation – HACI (without External Factors) * Income Diversification

		Number of significant (at least 20% contribution to total income) sources of household income				
		One	Two	Three	More than three	Total
Household Adaptive Capacity Index without External Factors	-1.00	1	0	0	0	1
	.00	3	0	0	0	3
	1.00	4	0	0	0	4
	2.00	2	1	0	0	3
	3.00	5	1	0	0	6
	4.00	12	5	0	0	17
	5.00	15	7	2	2	26
	6.00	15	17	2	0	34
	7.00	23	24	0	0	47
	8.00	10	30	2	0	42
	9.00	10	36	4	0	50
	10.00	10	28	1	0	39
	11.00	9	11	3	0	23
	12.00	3	19	3	0	25
	13.00	3	11	3	2	19
	14.00	3	8	0	0	11
	15.00	2	6	2	0	10
	16.00	1	4	2	0	7
	17.00	0	2	3	0	5
	18.00	1	1	1	2	5
	19.00	0	1	3	0	4
	20.00	0	1	5	0	6
	21.00	0	3	3	0	6
	22.00	0	0	1	3	4
	23.00	0	0	0	1	1
	24.00	0	0	1	0	1
	25.00	0	0	1	0	1
	26.00	0	0	0	2	2
	27.00	0	0	1	0	1
Total		132	216	43	12	403

The values inside table 38 are numbers of households, for instance, 3 households had one source of income each and a HACI of 0 (zero).

Interconnectivity to Higher Level Processes and Adaptability: It has been indicated that group membership and networks convey certain benefits to adaptation. Figure 42 shows a graphical presentation of the relationship between the HACI and the number of groups in which a household is represented. Respondents confirmed that networking, reciprocal relationships and group participation support adaptability.

Figure 42: HACI and Group Membership



The study also observed that membership and participation in groups tended to vary with income. An assessment of the two extremes of the income continuum revealed, among other things, that poorer households tended to shy away from membership to and active participation in groups and lending organisations for lack of money for registration and contribution fees besides the embarrassment associated with frequently lacking funds for group activities. This was also the case when it came to attending church services for they (poorer households) reported that they often lacked money for offertory/contributions. Such

issues constituted significant barriers to entry into and participation in groups among low income (often also low adaptability) households.

At the other extreme, some higher income households tended to minimise their participation in group activities and projects alleging that they preferred to spare themselves embarrassments associated with poor politics, dishonesty and management wrangles. In the words of one household head, "There is no need of joining groups and spending a lot of time and energy for peanuts". This is likely to be due to a phenomenon of declining marginal returns to group membership as income rises *ceteris paribus*.

Susceptibility to Environmental Stress and Vulnerability (Low Level of Adaptability): As can be seen in the following cross tabulation, a larger share of the contribution of agriculture to household income tended to be associated with increased perception that risks were worsening. Respondents were asked whether or not they felt more vulnerable compared to the preceding five years. From table 39, it can be seen that approximately 86 per cent of the households who had farming as their main base of livelihood reported a perception of increased risk.

Table 39: Cross Tabulation - Importance of Farming to Household Wellbeing * Perception of Increased Threat due to Environmental Stress

		Perception of increased threat due to environmental stress compared to previous 5 years		
		Yes	No	Total
Contribution of farming to household wellbeing	Main base of livelihood	251	41	292
	Equally important alongside other livelihood base	69	20	89
	Less significant livelihood base	16	6	22
Total		336	67	403

5.18 Institutional and Infrastructural Environment (the External Sub-Index)

The discussions in the just concluded sections of this chapter have been done using the HACI calculated without external factors to enhance depth and clarity. This section now presents the descriptive statistics for the external sub-index as well as those of its variables and shows how some of the factors largely beyond a household's control affect household adaptability. The results are elucidated for the external sub-index's variables as follows:

a) Common Property Access

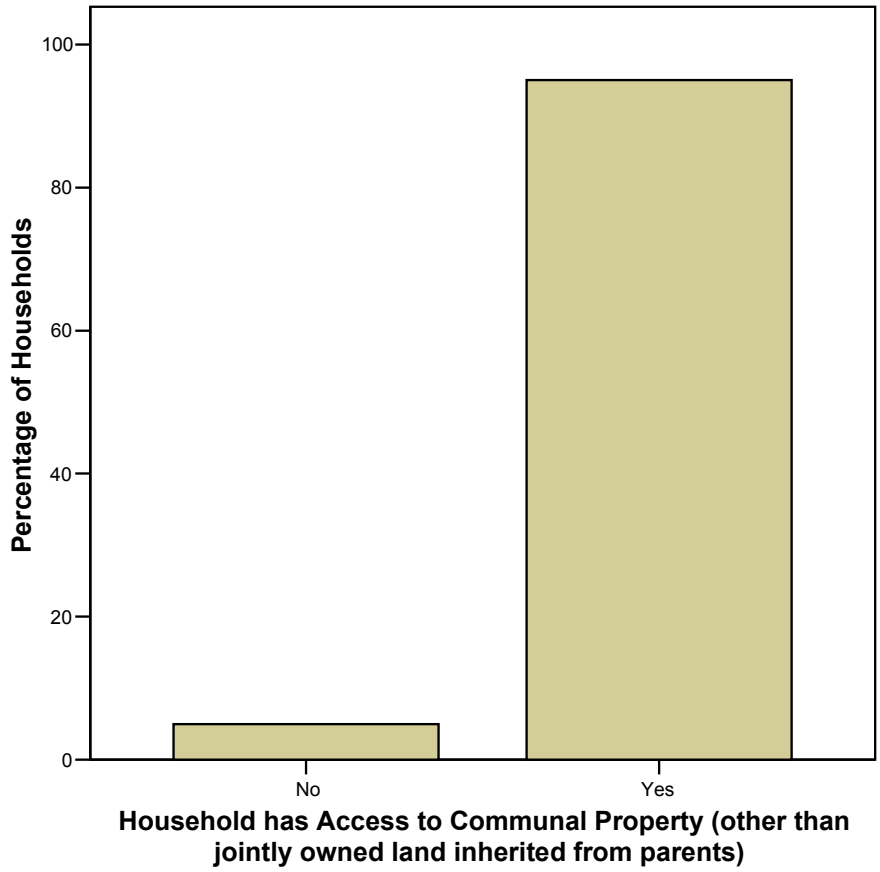
In cases where negative environmental changes such as degraded soils, erratic rainfall and depleted forest cover impact livelihoods of households with small landholding, availability of common resources may help compensate for supply deficits. Rapid population growth leading to decimation of landholding and over-cultivation of the available small parcels of land in rural areas not only fuels soil degradation but also leaves very little room for private grazing areas. Even though access to common property has massively declined over the past decades, the farming households of Kakamega district reported to still enjoy some communal property benefits as summarised in table 40 and figure 43.

Table 40: Communal Property Access (Other than Jointly Owned Land Inherited from Parents)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	20	5.0	5.0	5.0
	Yes	383	95.0	95.0	100.0
	Total	403	100.0	100.0	

For more visual acuity, the information in table 40 is graphically presented in figure 43.

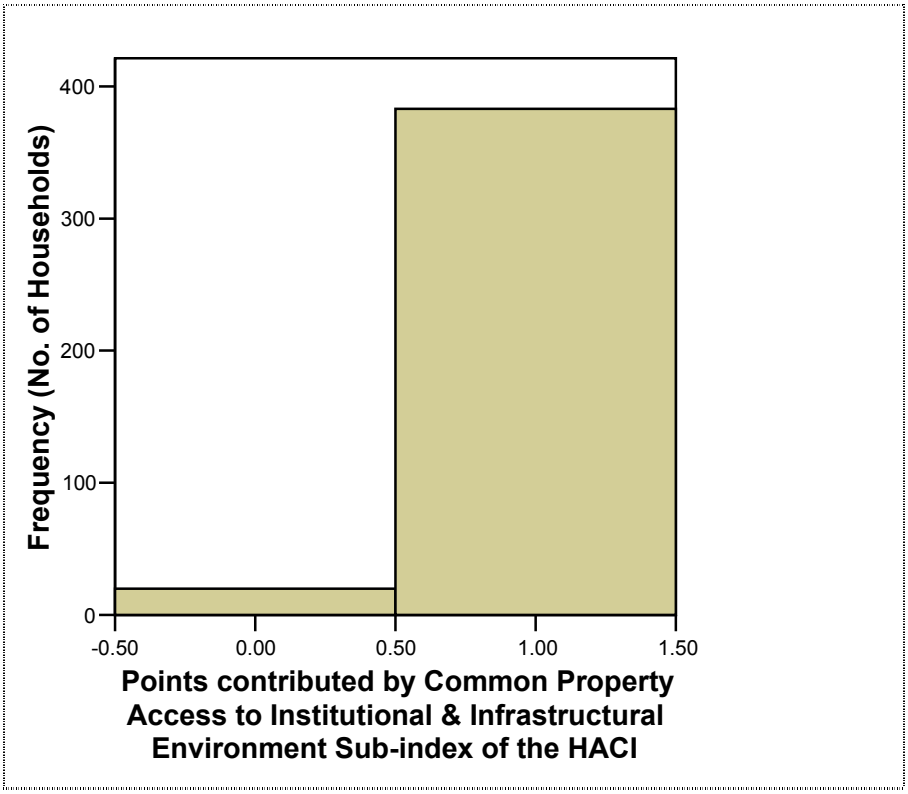
Figure 43: Household Access to Communal Property



Common Property Access as an Intermediate Variable: As already shown, over 90 per cent of the households reported having some access (however limited) to common property, for instance, pasture land. For rural households keeping goats and sheep in the area of study, communal land offered a much needed alternative for pasture given that grazing in forest land attracted user fees yet monetary resources were often very limited. In some sections of the forest, goats were not allowed due to their feeding habits (as opposed to cows that feed on grass, goats prefer to feed on leaves) that often destroyed vegetation faster and threaten regeneration.

In cases where households had access to communal property, the indicator assumed a value of 1 and where there was no communal property useable by households, the indicator assumed a value of 0 (zero). The indicator - access to communal property other than clan land - supplied the values of the variable 'access to common property' which in turn contributed to the sub-index 'institutional and infrastructural environment' as presented in figure 44.

Figure 44: Integrating Access to Common Property into HACI



This contribution complemented that of the other two variables (access to public services and household's physical location) in building up the sub-index 'institutional and infrastructural environment'.

b) Public Service Access

This intermediate variable had three lower level variables (indicators). These were:

i) Visits by public agricultural extension officers

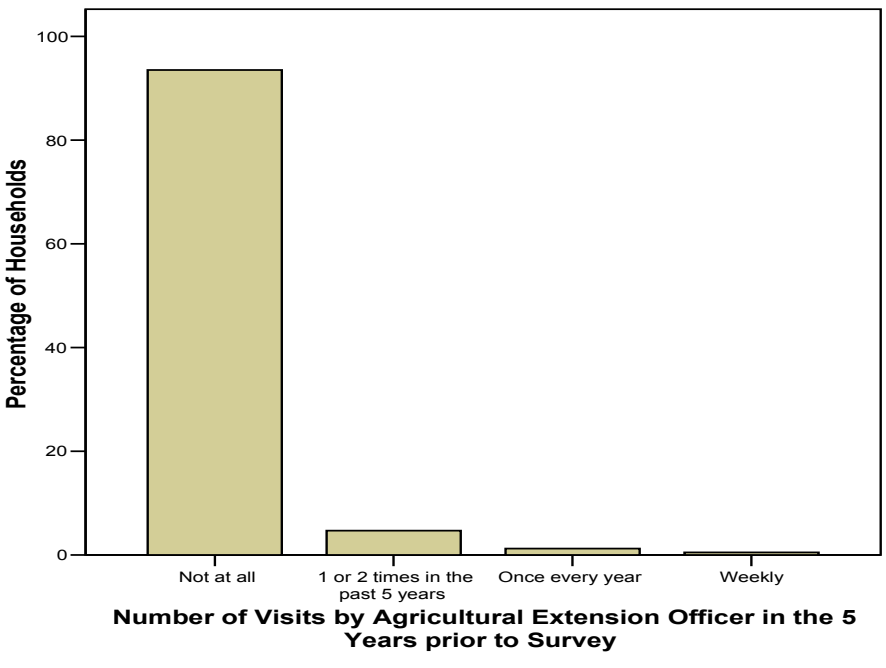
Appropriate farming practices were identified to be an important factor for household adaptability and access to the same was used to gauge the extent of access to public services. In the past, some agricultural extension officers in the public service moved around the villages in the area promoting proper agricultural practices among farming households. Perhaps indicative of the greatly diminished access to public services of relevance to adaptation, over 93 per cent of the households in the sample reported that they had never been visited (served) by an agricultural extension officer over the five year period preceding the survey. The table 41 and figure 45 summarise the descriptive statistics.

Table 41: Frequency of Visits by Agricultural Extension Officers over Previous 5 Years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	377	93.5	93.5	93.5
	1 or 2 times in the past 5 years	19	4.7	4.7	98.3
	Once every year	5	1.2	1.2	99.5
	Weekly	2	.5	.5	100.0
	Total	403	100.0	100.0	

For more visual acuity, information in table 41is graphically presented in figure 45.

Figure 45: Number of Visits by Agricultural Extension Officer



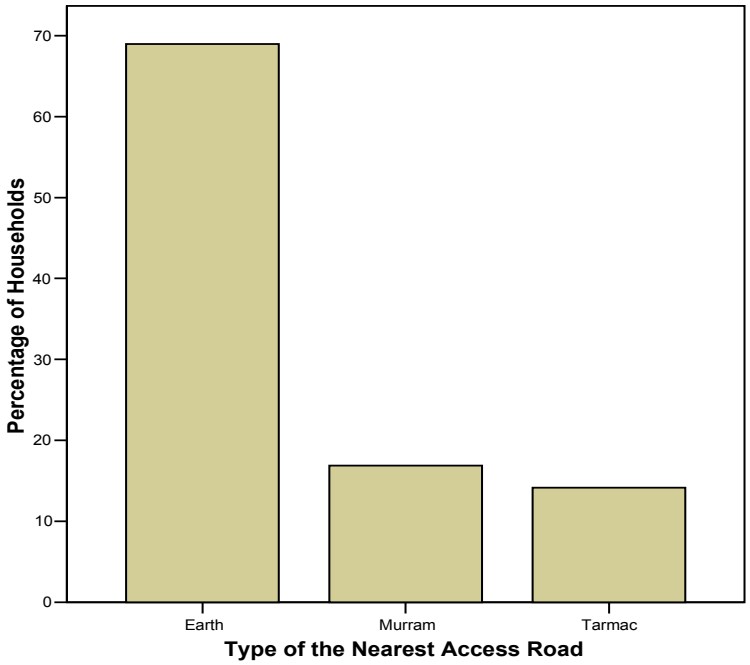
ii) Type of Access Road

Roads enable people to move from their homes to public offices to seek services. In the area of study, the type of access road determines whether or not a person obtains urgently needed services from government offices or not (earth roads often became impassable during rainy days). Since road building and maintenance in the area of study was the responsibility of the government, the type of access road served to indicate the level of supply of government services. It was found out that only 14 per cent of the households were served with tarmac roads while 70 per cent had to use earth roads. For those that had to use earth roads, access to critical services could be hindered by the cost; time involved and weather (besides emotional distance). The households served with tarmac roads had a relatively better access to public services since they took relatively less time and incurred relatively less costs to procure services and therefore they were better placed to adapt. A summary of the descriptive statistics of this lower level variable has been provided in table 42 followed by a graphical presentation of the same information in figure 46 for better visual acuity.

Table 42: Observations on Types of Access Road Nearest to Households

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Earth	278	69.0	69.0	69.0
	Murram	68	16.9	16.9	85.9
	Tarmac	57	14.1	14.1	100.0
	Total	403	100.0	100.0	

Figure 46: Statistics on Types of Access Roads Nearest to Households



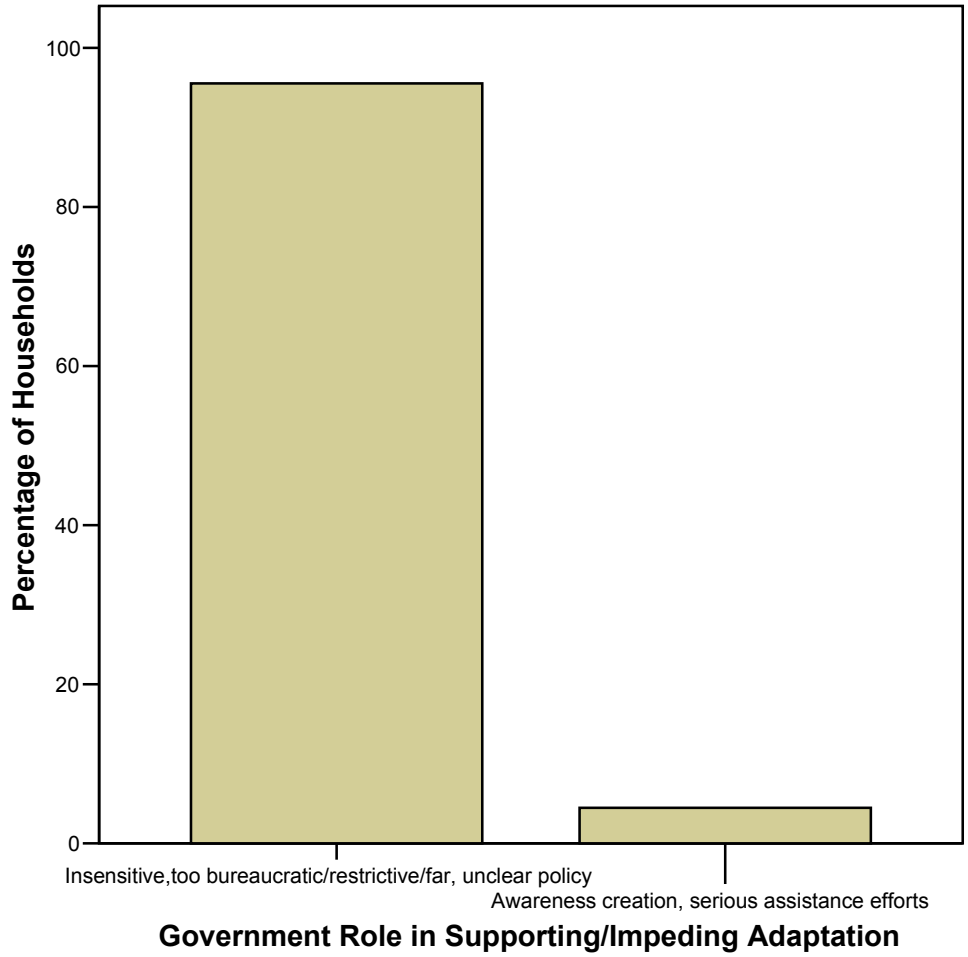
iii) Household perception of the government's role in enhancing adaptation

Over 95 per cent of the households felt that the government had not done enough in supporting adaptation in the area with positive sentiments for government action coming only from less than 5 per cent of the households. The summarised results of this lower level variable are illustrated table 43 and figure 47.

Table 43: Perception on Government Role in Supporting/Impeding Adaptation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Insensitive,too bureaucratic/restrictive/far, unclear policy	385	95.5	95.5	95.5
	Awareness creation, serious assistance efforts	18	4.5	4.5	100.0
	Total	403	100.0	100.0	

Figure 47: Views on Government Role in Supporting/Impeding Adaptation



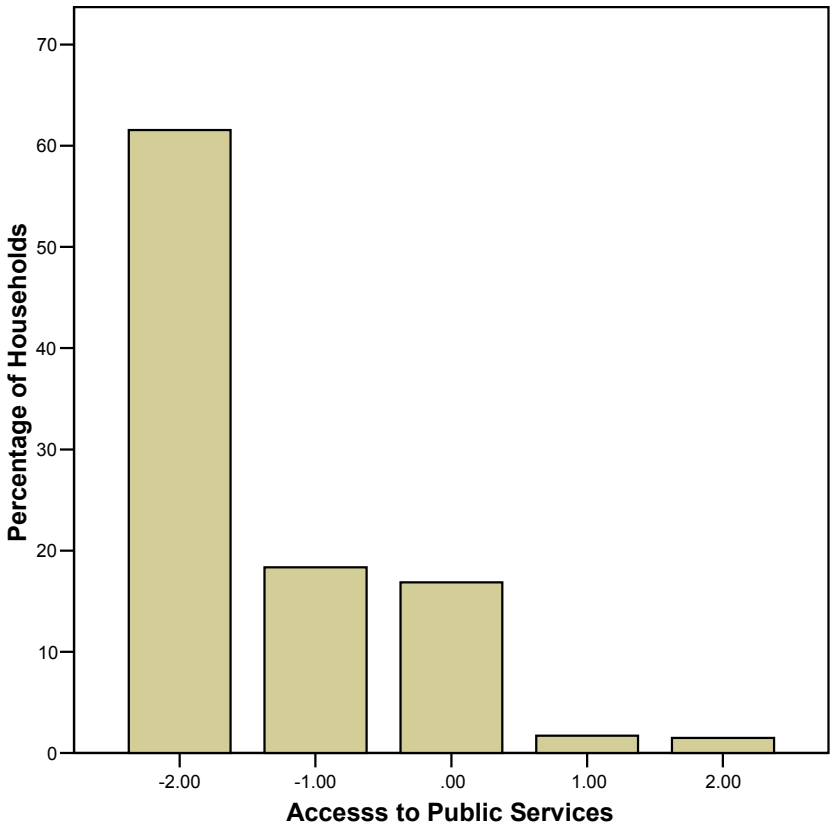
Calculated Values for Household Access to Public Services: By aggregating the contributions from the three lower level variables (number of visits by agricultural extension

officers, type of access road and government role in enhancing or impeding adaptation) the values of the intermediate variable (household access to public services) were obtained. The statistics of the intermediate variable reveal that only about 20 per cent of the households interviewed had a fair access to public services. Nearly 80 per cent of the households experienced adaptation-hurting effects due to their level of access to public services. The results are summarised in table 44 and figures 48 and 49. An observation of 0 (neutral) means that the household's level of access to services neither hurt nor promoted adaptability while negative and positive values are associated with various levels of adaptation-hurting and adaptation-promoting levels of access to public services respectively.

Table 44: Household Access to Public Services

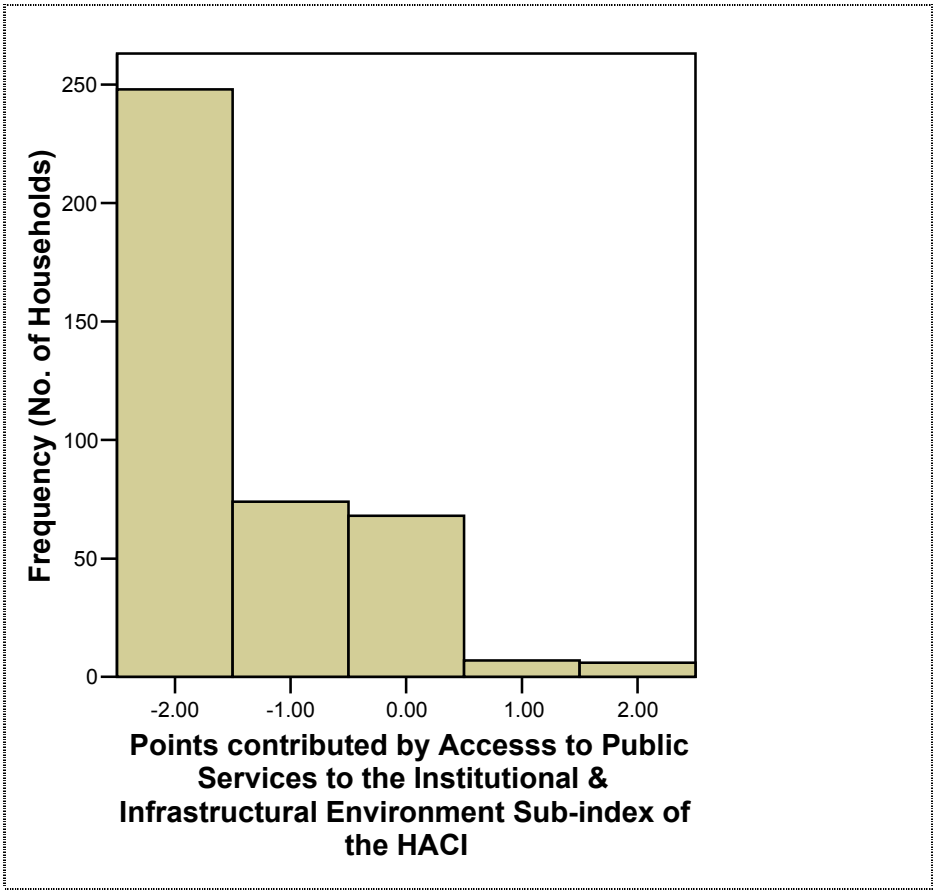
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-2.00	248	61.5	61.5	61.5
	-1.00	74	18.4	18.4	79.9
	.00	68	16.9	16.9	96.8
	1.00	7	1.7	1.7	98.5
	2.00	6	1.5	1.5	100.0
	Total	403	100.0	100.0	

Figure 48: Level of Access to Public Services by Household



The individual values of this intermediate variable – access to public services – constituted its contributions to the sub-index of institutional and infrastructural environment as summarised in figure 49.

Figure 49: Integrating Access to Public Services into HACI



These were used together with the contributions from access to common property and those from 'household's physical location' to build up the external sub-index.

c) Household's Physical Location

This variable had three indicators (lower level variables) which were observed in order to pick up the effects of households' physical location relative to important institutions, markets (key in obtaining fairer prices for products) and infrastructure such as access roads (key in getting products to and from markets) on adaptive capacity. The indicators revealed the following:

i) Distance between the household and divisional headquarters

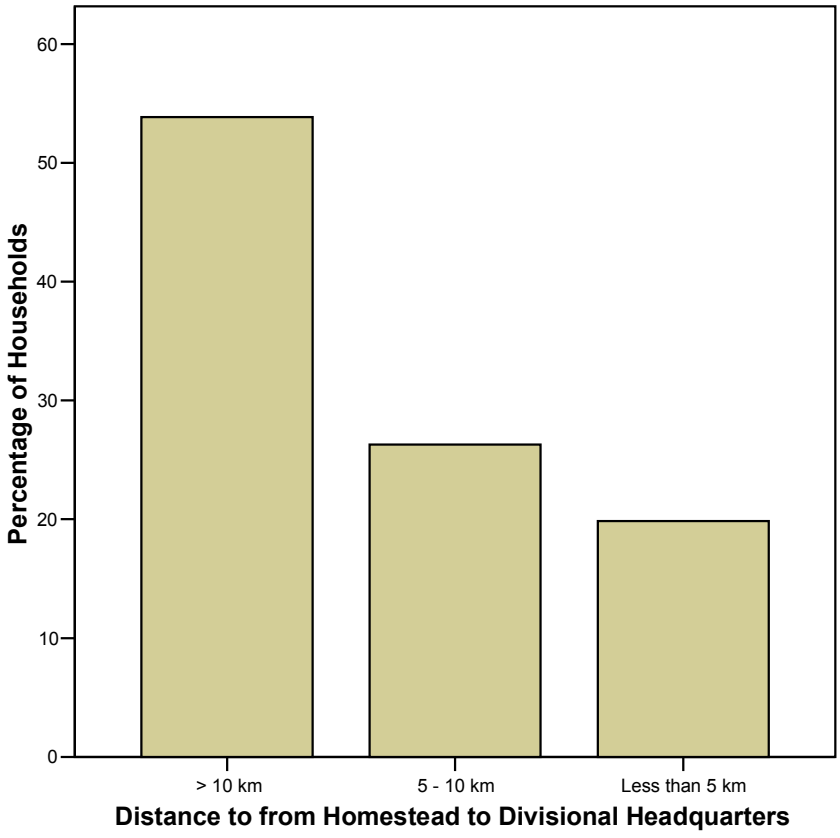
Nearly 54 per cent of the households were located more than 10 kilometres away from the divisional headquarters. Summaries have been provided in table 44 and figure 50. Great geographical distances implied that key activities taking place in government offices like

obtaining vital identification or registration documents (useful in loan application, processing of claims/benefits, school enrolment and starting a business among other things) were too time taking for the households in question. Geographical distance tended to deepen the negative effects from emotional distance, poor roads and the overall monetary costs involved on adaptability. A delay in obtaining an identification card could mean missing a crucial micro credit opportunity which would have boosted adaptability.

Table 45: Distance to Divisional Headquarters

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	> 10 km	217	53.8	53.8	53.8
	5 - 10 km	106	26.3	26.3	80.1
	Less than 5 km	80	19.9	19.9	100.0
	Total	403	100.0	100.0	

Figure 50: Household's Distance from Divisional Headquarters



ii) Distance between the household and the nearest market

About 40 per cent of the households were located more than 10 kilometres away from the market centres at which they sold or bought commodities like livestock and equipment. Table 46 presents this information.

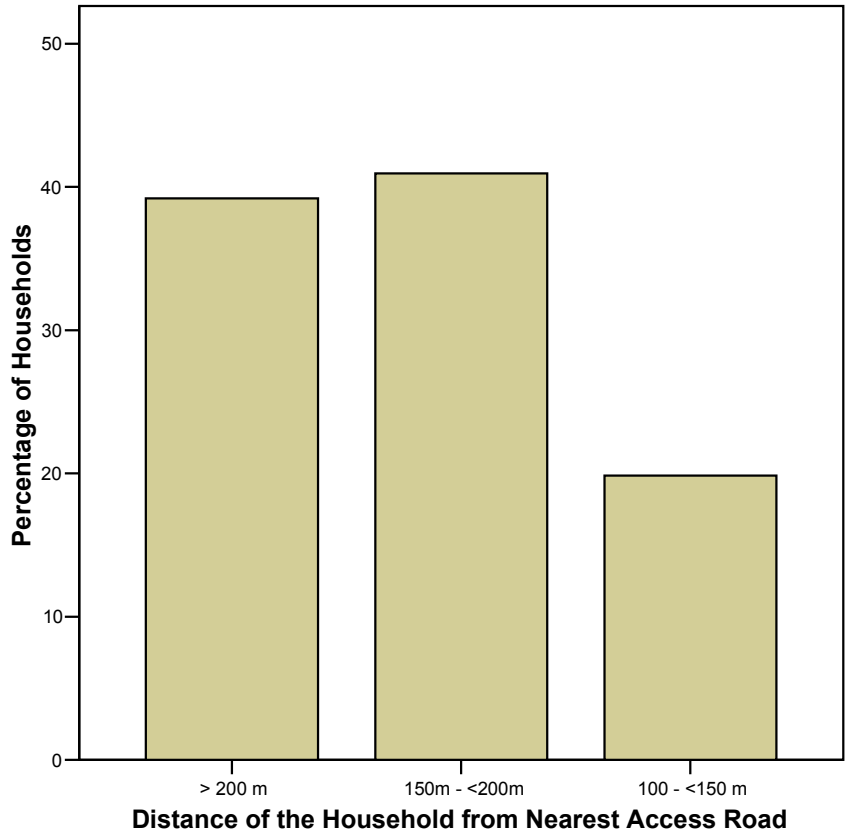
Table 46: Distance of Household from Nearest Market

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	> 10 km	158	39.2	39.2	39.2
	5 - 10 km	165	40.9	40.9	80.1
	Less than 5 km	80	19.9	19.9	100.0
	Total	403	100.0	100.0	

iii) Distance between the household and the nearest access road

Slightly over 39 per cent of the households were located over 200 metres away from the nearest access road (useable to take commodities to nearest market or deliver purchases home). Information on distance of households from nearest access roads has been summarised in figure 51.

Figure 51: Distance of Household from Nearest Access Road



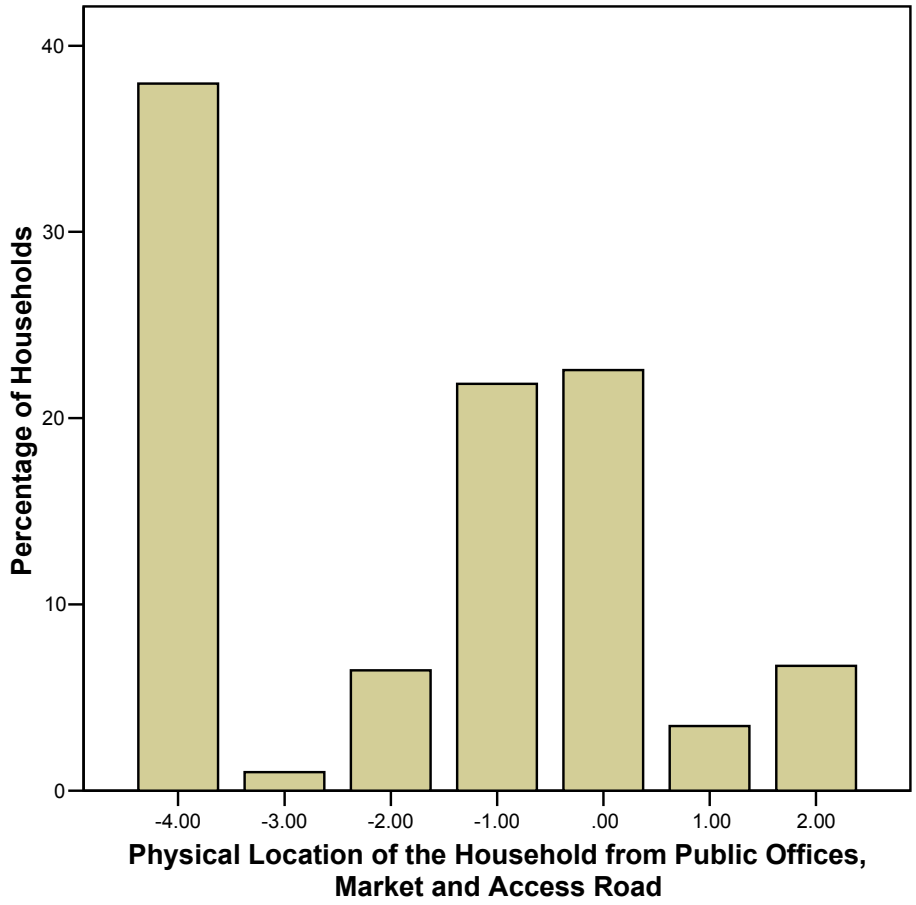
Calculated Values for Physical Location of Households: The contributions from the three lower level indicators (distance to divisional headquarters, distance to market and distance to nearest access road) were aggregated to yield the individual values of the intermediate variable (physical location of the household). About 10 per cent of all the households had a positive effect on their adaptability by virtue of their geographical location (near markets,

public offices and/or key access roads) compared to 22.6 per cent that displayed little or no effect and 67.2 per cent that displayed negative effects. This information has been summarised in table 47 and figures 52 and 53.

Table 47: Physical Location of Households

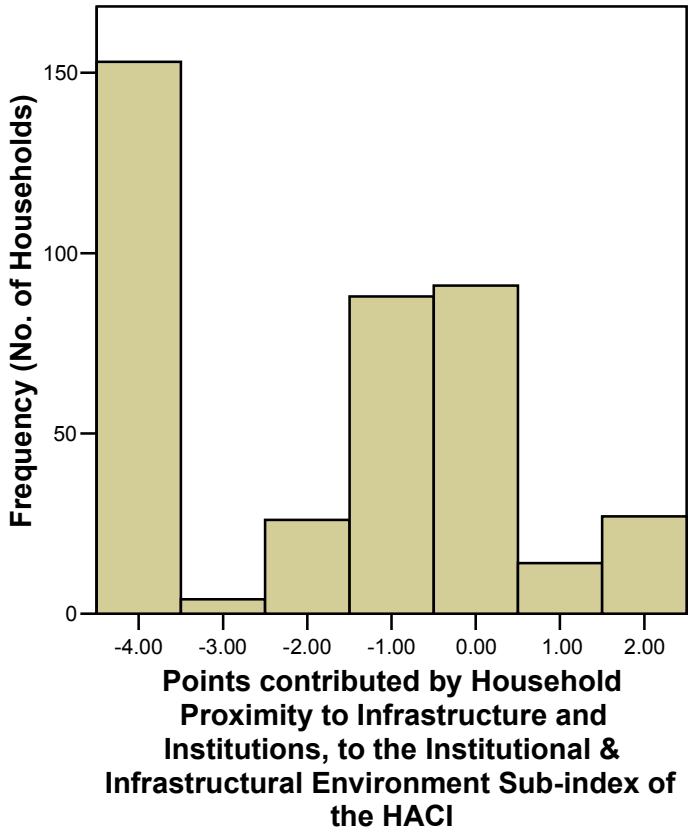
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-4.00	153	38.0	38.0	38.0
	-3.00	4	1.0	1.0	39.0
	-2.00	26	6.5	6.5	45.4
	-1.00	88	21.8	21.8	67.2
	.00	91	22.6	22.6	89.8
	1.00	14	3.5	3.5	93.3
	2.00	27	6.7	6.7	100.0
	Total	403	100.0	100.0	

Figure 52: Physical Location of Households from Critical Points



The variable – household's physical location – contributed points to the sub-index – institutional and infrastructural environment – as graphically presented in figure 53.

Figure 53: Integrating Household Proximity to Infrastructure & Institutions into HACI



Now, taking all the contributions from the three intermediate variables: Access to common property, access to public services and physical location of the household (relative to key infrastructure and institutions), yielded the individual values of the external sub-index (institutional and infrastructural environment).

Calculated Values for Institutional and Infrastructural Environment: The contribution of this sub-index to the HACI ranged from -6 to 4 points. In a nutshell, over 78 per cent of households in the sample had negative effects on their adaptive capacities due to the existing institutional and infrastructural environment. The relevant statistics have been summarised in table 48 and figures 54 and 55. It can be seen that only about 17 per cent of the households reported positive impacts from the existing institutional and infrastructural environment to the HACI.

Table 48: Institutional and Infrastructural Environment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-6.00	3	.7	.7	.7
	-5.00	91	22.6	22.6	23.3
	-4.00	51	12.7	12.7	36.0
	-3.00	29	7.2	7.2	43.2
	-2.00	70	17.4	17.4	60.5
	-1.00	71	17.6	17.6	78.2
	.00	18	4.5	4.5	82.6
	1.00	47	11.7	11.7	94.3
	2.00	7	1.7	1.7	96.0
	3.00	14	3.5	3.5	99.5
	4.00	2	.5	.5	100.0
	Total	403	100.0	100.0	

Figure 54: Distribution of the Sub-Index of Institutional and Infrastructural Environment

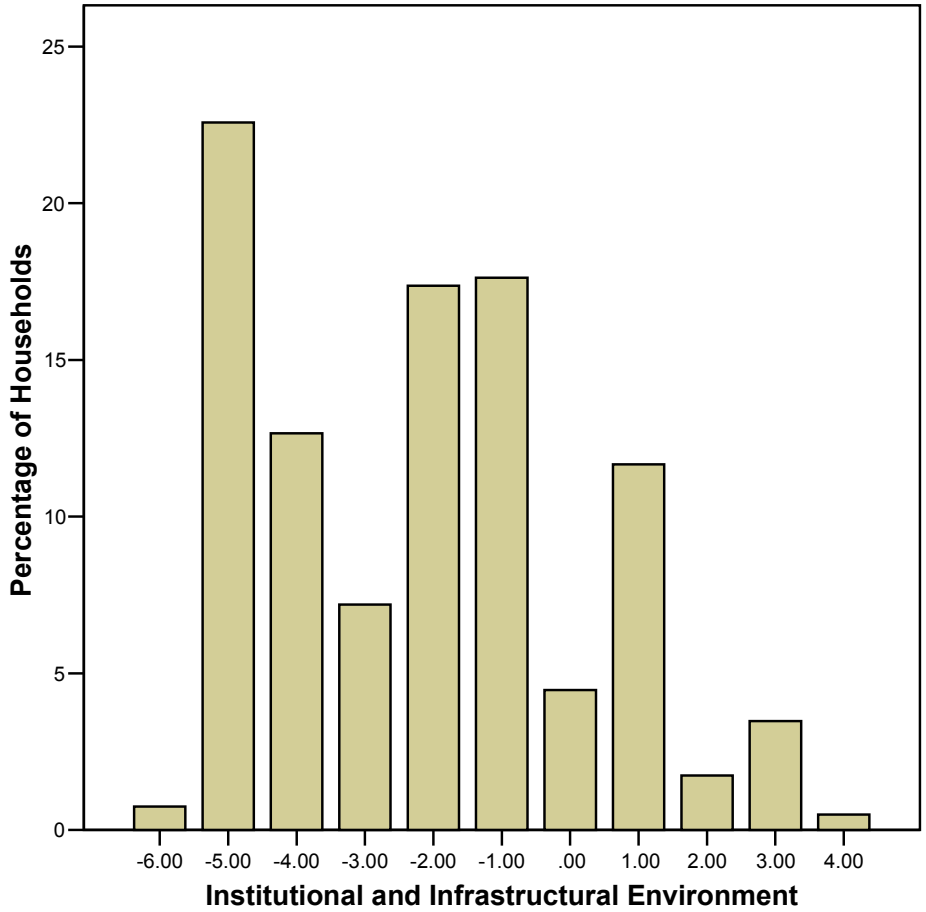
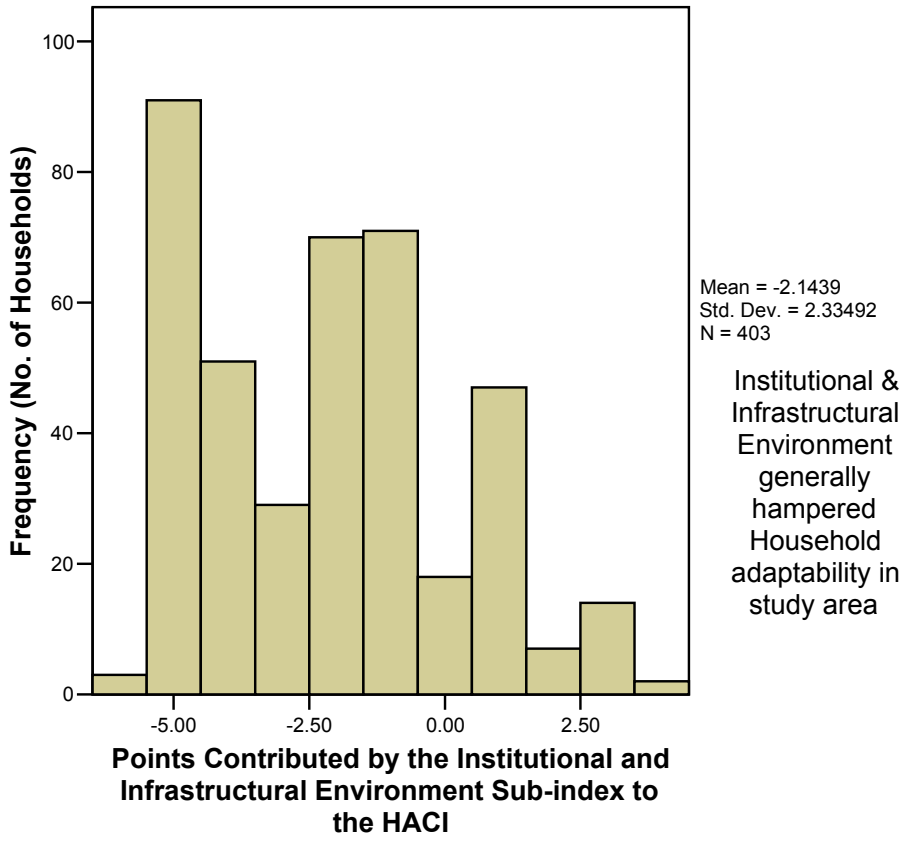


Figure 55 provides the distribution of values (contribution) of this sub-index.

Figure 55: Integrating the External Sub-index of Institutional & Infrastructural Environment into HACI



5.2 HACI including the External Sub-index of Institutional and Infrastructural Environment: Including the external sub-index had the general result of further weakening the adaptive capacity of poorer households with a new range of 33 (up from 29) being attained. This information is graphically presented in table 49 and figures 56 and 57.

Taking external factors into consideration significantly changed the distribution of HACI. At the high-end of the values of HACI, the effect of external factors was less dramatic as the highest observed HACI remained at 27 (same as without the external sub-index). However, there was a marked difference at the middle and lower regions. Taking a HACI of 11 as a reference point for instance, it was observed that approximately 8.2 per cent of the households slid downwards to exhibit HACIs less than 11 (given that analysis using the HACI without the external sub-index showed that about 73.2 per cent of the households had HACIs of 11 and below but the analysis done after incorporating the external sub-index showed that 81.4 per cent of the households had HACIs of 11 and below). Moreover, the lowest observed HACI shifted downwards from -1 (in the case of HACI without the external sub-index) to -5.

Table 49: HACI incorporating Institutional & Infrastructural Environment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-5.00	1	.2	.2	.2
	-2.00	2	.5	.5	.7
	-1.00	6	1.5	1.5	2.2
	.00	17	4.2	4.2	6.5
	1.00	15	3.7	3.7	10.2
	2.00	22	5.5	5.5	15.6
	3.00	28	6.9	6.9	22.6
	4.00	33	8.2	8.2	30.8
	5.00	41	10.2	10.2	40.9
	6.00	27	6.7	6.7	47.6
	7.00	35	8.7	8.7	56.3
	8.00	30	7.4	7.4	63.8
	9.00	28	6.9	6.9	70.7
	10.00	24	6.0	6.0	76.7
	11.00	19	4.7	4.7	81.4
	12.00	15	3.7	3.7	85.1
	13.00	12	3.0	3.0	88.1
	14.00	5	1.2	1.2	89.3
	15.00	7	1.7	1.7	91.1
	16.00	5	1.2	1.2	92.3
	17.00	3	.7	.7	93.1
	18.00	10	2.5	2.5	95.5
	19.00	5	1.2	1.2	96.8
	20.00	4	1.0	1.0	97.8
	21.00	3	.7	.7	98.5
	23.00	2	.5	.5	99.0
	24.00	1	.2	.2	99.3
	25.00	1	.2	.2	99.5
	27.00	2	.5	.5	100.0
	Total	403	100.0	100.0	

As may be seen from figure 57, a new arithmetic mean of 7.5 was obtained for the HACI (with external sub-index).

Figure 56: Distribution of HACI after incorporating External Sub-Index

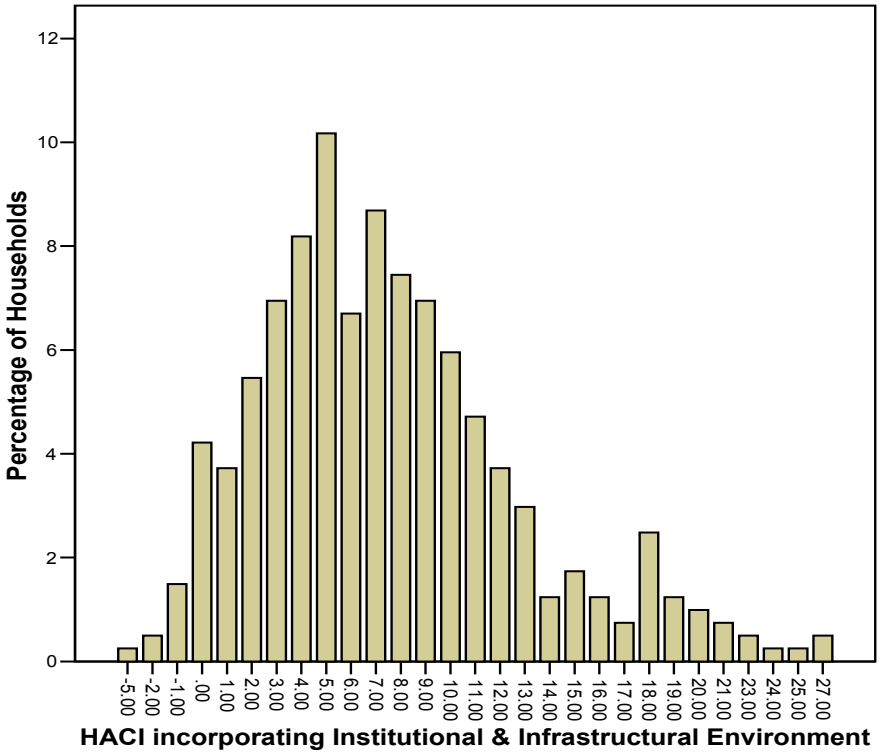


Figure 57: Distribution of the HACI Showing Averages after incorporating External Sub-Index

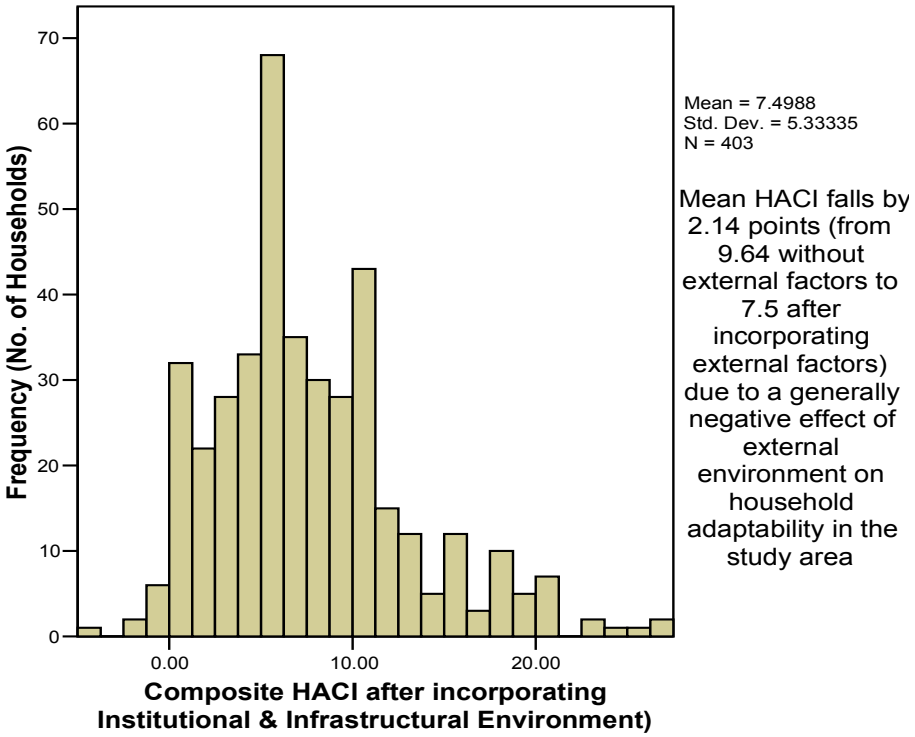
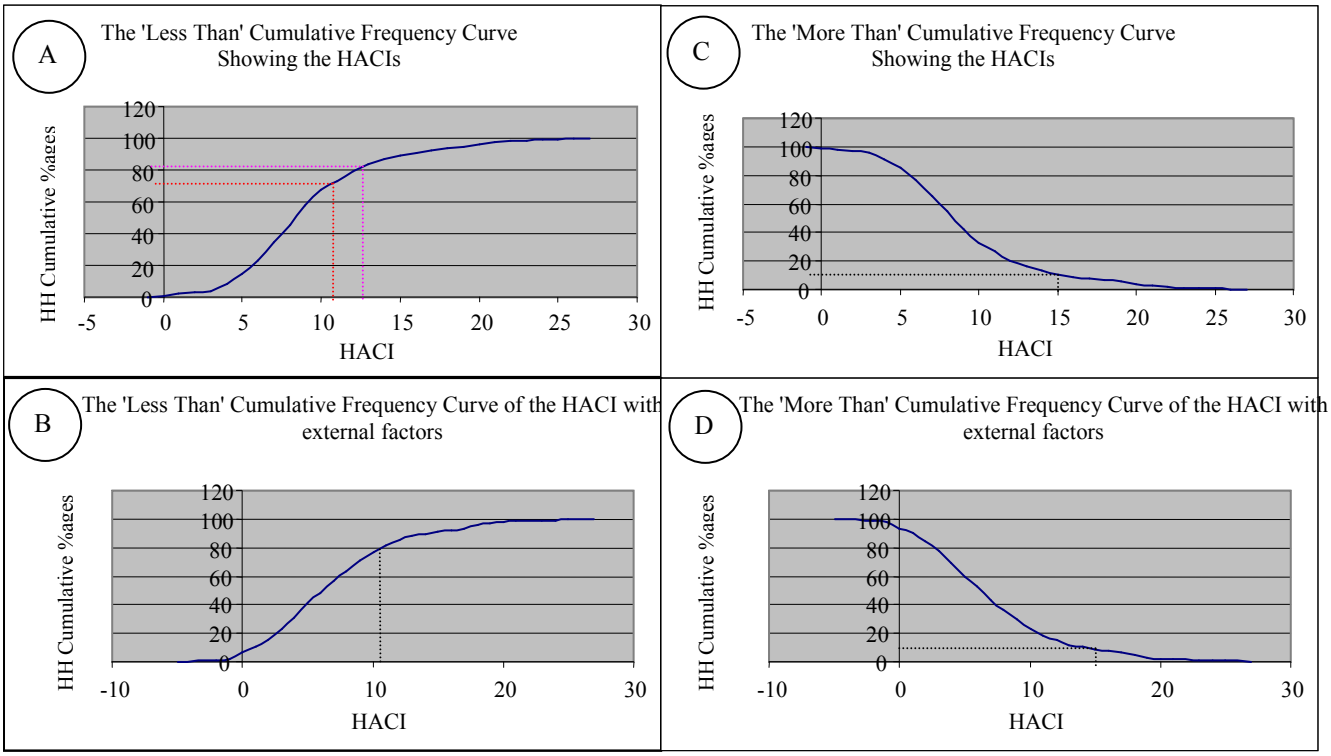


Figure 58 presents cumulative frequency (percentage) curves that serve to illustrate the difference due to the external sub-index. On the parts of the figure marked 'A' and 'B' are 'less than' cumulative frequency curves showing the percentage of households with HACIs below a given figure, say 11. On the parts marked 'C' and 'D' are the 'more than' cumulative frequency curves showing the percentage of households with HACIs beyond a given figure, say 15.

Figure 58: Comparative Cumulative Frequency Curves



A: Top Left; without external factors, 73.2 per cent of the households had HACIs of 11 and below

B: Bottom Left; with external factors, 81.4 per cent of the households had HACIs of 11 and below, a marked deterioration involving 8.2 per cent of households (some fell off the transitional region of 10 – 14).

C: Top Right; without external factors, about 13 per cent of the households had a HACI of 15 and above

D: Bottom Right; with external factors, only 10.4 per cent of all the households had a HACI of 15 and above (difference of 2.1 per cent representing households slipping down into the transitional region).

Perhaps underscoring the relative stability of household adaptability among the households featuring HACIs of 15 and above, inclusion of the external sub-index impacted the transitional and low HACI groups of households more intensely than was the case for the group of households with HACIs at or above the threshold. An inspection of the results supports the conclusion that, apart from impacting household adaptability via limited opportunities for paid employment which perpetuates high levels of reliance on environment/climate-sensitive resources, being rural also tended to weaken the adaptive capacity of households due to poorer access to critical services. The improvement of the overall institutional and infrastructural environment (for instance, through the decentralisation of public services) therefore has a significant role to play in improving rural household adaptability.

5.3 Hypothesis Testing

To facilitate closer assessment, this section holds external variables constant and uses the HACI without the external sub-index to examine some relationships and facilitate the testing of the study hypotheses.

5.3.1 Optimal Farm Input Use and the HACI

During a previous research exercise carried out by the author in the area of study, a number of farming households expressed frustrations after investing in inorganic fertilizer on their farms and obtaining less-than-impressive harvests. Thanks to the prevalent erratic rainfall, many farming households did not often recoup their investments in farm inputs and this dampened their motivation to invest in farm inputs during subsequent planting seasons. Some farming households however reported that they were happy to have received even the little harvest they obtained in times when harvests were generally bad. The second category of farmers praised inorganic fertilizers, saying they would have been worse off in poor harvest periods if they did not use the inorganic fertilizer (farm inputs). The dissertation sought to find out whether or not the use of farm inputs made a difference in household adaptability in face of the increasing rainfall variability. Given that some households often borrowed to purchase farm inputs, poor harvests with unpaid loans would push them into weaker adaptability conditions in face of environmental stress.

It was observed that improved seeds and fertilizer (farm inputs) had been widely adopted by the households in the sample even though the use of the inputs in the appropriate quantities

tended to be undermined by the low purchasing powers of the rural households. Most farmers engaging in food crop production (particularly maize and beans) reported using both improved and traditional seeds. Table 50 shows use of farm inputs according to percentages of respondents. An assessment of the level of regular and adequate application of improved seeds at each planting time showed the results displayed in table 51. Only 10.7 per cent reported using the appropriate quantity of improved seeds each time they planted. Use of improved seeds depended on the money farmers had at planting time and the costs of the seeds.

Table 50: Input Use Statistics

Input type	Percentage of respondents using it	Percentage of respondents using it every planting time	Percentage of respondents that exhibit changes in farm input use over the previous 5 years		
			Increase	Constant	Decrease
Improved seeds	63.5	62	31.3	10.9	21.3
Compost manure (FYM)	74.7	70	50.4	12.9	11.9
Inorganic fertilizer	85.6	84.6	47.1	15.9	21.6

Table 51: Extent of Use of Improved Seeds as Recommended for Farm-Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	All the times	43	10.7	10.9	10.9
	75% of the times	63	15.6	15.9	26.8
	50% of the times	82	20.3	20.8	47.6
	Occasionally (<50% of the time)	72	17.9	18.2	65.8
	Never	135	33.5	34.2	100.0
	Total	395	98.0	100.0	
Missing	Respondent can't tell	8	2.0		
Total		403	100.0		

Regarding the appropriate use of organic fertilizer, only 15.1 per cent (shown in table 52) reported applying the right quantity every planting time. For the rest of the farmers using fertilizer, cost implications meant that they sometimes could not afford adequate fertilizer for their farms. Where the money available at planting time was inadequate for improved seeds and inorganic fertilizer, farmers gave priority to purchasing inorganic fertilizer which they could then apply to traditional seed varieties.

Table 52: Extent of Use of Inorganic Fertilizer as Recommended for Farm-Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	All the times	61	15.1	15.1	15.1
	75% of the times	76	18.9	18.9	34.0
	50% of the times	135	33.5	33.5	67.5
	Occasionally (<50% of the time)	77	19.1	19.1	86.6
	Never	54	13.4	13.4	100.0
	Total	403	100.0	100.0	

Given the fact that environmental stress (soil degradation and loss of vegetation) and climate variability were the phenomena to which rural households in Kakamega had to respond, the regular use of farm inputs (like inorganic fertilizer and improved seeds) were expected (a priori) to significantly improve yield from the degraded soils. However, a certain minimum amount of precipitation is required at the appropriate times during the growing periods so as to realise reasonable or improved harvests even when using the farm inputs optimally. The dissertation employed the observations on optimal use of inorganic fertilizers to test the hypothesis that regular and optimal farm input use positively contributes to a household's adaptive capacity index under the prevailing conditions. Inorganic fertilizer constitutes the leading group of farm inputs purchased by many rural households and are therefore good representatives. In dichotomising the households, optimal usage of inorganic fertilizers in over 75 per cent of the times a household plants, was picked to represent regular and optimal usage of farm inputs while anything below 75 per cent of the times was taken to constitute irregular usage of the same.

If farm input use positively contributes to the HACI, then the mean HACI of households regularly and optimally using farm inputs would be significantly higher than that of the households not regularly and optimally using farm inputs. On the other hand, if the regular and optimal farm input use had an insignificant impact on the HACI (may be due to other intervening factors like rainfall variability/low precipitation), then the mean HACIs of the two groups would be equal (would display no significant difference). The study used the t-test for equality of means to find out whether the mean HACI of households regularly and optimally using farm inputs was different from that of households not regularly and optimally using farm inputs. The null and alternative hypotheses were:

H_0: Regular and optimal farm input use has no significant impact on the HACI: $\mu_1 = \mu_2$

H_A: Regular and optimal farm input use has a significant impact on the HACI: $\mu_1 \neq \mu_2$

Using the Independent Samples T-Test in SPSS, the mean HACIs of two sub-samples of households were compared. That of households regularly and optimally using organic fertilizers = $\overline{x}_1$ and that of households which did not regularly and optimally use organic fertilizers = $\overline{x}_2$ in the area of study. The test was done at 95 per cent confidence interval of the difference (5 per cent significance level) and, as shown in the following tables, it turned out that there was a significant difference between the two means (significance = 0.000; for a two tailed test, equal variances not assumed).

Table 53: Group Statistics (Input Use)

	Household uses inorganic fertilizer as recommended for its size of farm	N	Mean	Std. Deviation	Std. Error Mean
Household Adaptive Capacity Index without External Factors	>= 3	266	8.3120	3.77434	.23142
	< 3	137	12.2263	5.15922	.44078

During the survey, household responses regarding regular and optimal use of inorganic fertilizers were grouped such that, 5 = 'never', 4 = 'sometimes but less than 50% of the time', 3 = '50% – 75% of the time', 2 = 'more than 75% but less than 100% of the time', and 1 = 'all the time'. In the above table, statistics for households which were regularly and optimally using organic fertilizers are included in the row 'Less than 3 (<3)' which includes responses 1 and 2 while statistics of households not using inorganic fertilizer regularly and optimal are shown in the row 'Greater or equal to 3 (>=3)' which includes responses 3, 4 and 5.

Table 54: Independent Samples Test (Input Use)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Household Adaptive Capacity Index without External Factors	Equal variances assumed	19.158	.000	-8.668	401	.000	-3.91425	.45160	-4.80204	-3.02645
	Equal variances not assumed			-7.862	213.004	.000	-3.91425	.49784	-4.89557	-2.93292

The mean of the HACIs of households with a history of regularly and optimally using inorganic fertilizer (farm inputs) was 12.23 as compared to the mean of the HACIs of the households that had not been regularly and optimally using inorganic fertilizers which was

8.31. With this result, the study rejected the null hypothesis thereby accepting the alternative one and confirming that the regular and optimal use of farm inputs positively affects the HACI even if rainfall variability and other factors intervened. However, there is bound to be a limit on the level of disturbances that may be accommodated. Indeed, as table 55 shows, slightly over 47 per cent of the households were using more inorganic fertilizer than they did three years prior to the survey in the face of degraded soils, erratic rainfall and disturbed ecosystems.

Table 55: Usage of Inorganic Fertilizer Compared to 3 Years prior to Survey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	More	190	47.1	55.7	55.7
	Less	87	21.6	25.5	81.2
	Same	64	15.9	18.8	100.0
	Total	341	84.6	100.0	
Missing	Household doesn't use it	62	15.4		
Total		403	100.0		

A further examination of the data showed that, in the area of inputs for livestock farming, 61.8 per cent of the households reported using acaricides while the use of improved feeds (6.2 per cent), pesticides (5 per cent) and artificial insemination services (6.2 per cent) recorded very low and stagnating rates of usage as did the services of the agricultural extension officers (summary in table 56). Most households (64.3 per cent) did not have reliable sources of agricultural information and the ones which had, relied on their interactions with local groups (12.9 per cent) with only 5.7 per cent using agricultural extension officers. A majority of households employed oxen plough and groups of manual labourers to do farm work with only 7.7 per cent reporting having hired a tractor in the twelve months prior to the survey.

Table 56: Number of Visits by Agricultural Extension Officer in 5 Years to Survey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	377	93.5	93.5	93.5
	1 or 2 times in the past 5 years	19	4.7	4.7	98.3
	Once every year	5	1.2	1.2	99.5
	Weekly	2	.5	.5	100.0
	Total	403	100.0	100.0	

Sub-optimal use of agricultural extension appeared to result not only from a low proximity to such officers but also from a lack of ability and willingness to pay (ineffective demand).

5.3.2 Credit (Loans) and the HACI

Even though the micro-finance movement has earned some accolades for believing in the poor, it has also been criticized for using huge sums of money from philanthropists to support micro and small enterprises, many of which are often necessity- rather than opportunity-based thereby offering little contribution to sustainable economic growth. Critics say that most of those necessity-based businesses die off sooner rather than later leaving the owners in debt or the lenders with negative returns. In Kenya, some micro-credit providers have also been observed to demand higher interest rates than some mainstream commercial banks. In early 2011, for instance, loans from the Kenya Women Finance Trust were offered at a 19 per cent rate of interest per annum when average bank lending rate in Kenya was around 15 per cent. Clients joining such MFIs in hope for cheaper credit often encountered difficulties over the repayment period and served to scare off potential borrowers.

Experience in Kakamega district, for instance, revealed a fairly high level of fear of loans among poor households (who would otherwise obtain investible loans based on group security). Perhaps rightly[43], many of the fearful potential beneficiaries gave the reason that the loans would bring more misery than happiness to their households since the risk of default and falling in a vicious cycle of debt was quite high. On the other hand, a few households appeared to be making progress with the help of loans borrowed on interest basis. Such households mostly used the loans for investment activities such as farming (purchasing livestock and inputs), small scale trading activities and payment of educational fees with varying levels of success. In the face of environmental stress and climate variability in Kakamega district, the dissertation sought to find out whether the use of loans or credit had a positive impact on household adaptability. The dissertation's second hypothesis was therefore based on the use of credit (loans) and its effect on the HACI.

Table 57: Loans Taken from Organisation in 12 Months prior to Survey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Loan taken	78	19.4	19.4	19.4
	No loan taken	325	80.6	80.6	100.0
	Total	403	100.0	100.0	

[43] Some minimum level of financial literacy and discipline is needed to productively use loans and repay in time. This often lacks among most poor households.

The descriptive statistics of loan-taking among the households in the sample were as presented in table 57.

Once more, the independent sample test in SPSS was used to compare mean HACIs of two sub-samples (one made up of households who had taken loans and the other made up of households who had not taken loans twelve months prior to the survey period) in an effort to test if the use of credit positively influences the HACI. If the taking and using of loans (credit) positively contributes to the HACI, then the mean HACI of households who had used or were using loans would be significantly higher than that of the households who had not used or were not using loans (alternatively put: mean HACI of the sample made up of loanees would be significantly lower if credit hurts adaptability as might happen if loanees end up in a vicious cycle of debt following drought-related losses of borrowed and invested agricultural finance). On the other hand, if using loans had an insignificant impact on the HACI, then the mean HACIs of the two groups would be approximately equal. The t-test for equality of means was used to find out whether the mean HACI of households who took loans was significantly higher than that of those who were not loanees. The null and alternative hypotheses derived from this analysis plan were:

H_0: Loan taking has no significant impact on the HACI: $\mu_1 = \mu_2$

H_A: Loan taking has a significant impact on the HACI: $\mu_1 \neq \mu_2$

The following two tables present the result of the test which was done at 95 per cent confidence interval of the difference (5 per cent significance level).

Table 58: Group Statistics (Loan Taking

	Loan taken from organisation within	N	Mean	Std. Deviation	Std. Error Mean
Household Adaptive Capacity Index without External Factors	Loan taken	78	11.0385	4.98945	.56494
	No loan taken	325	9.3077	4.53900	.25178

Table 59: Independent Samples Test (Loan Taking)

		Levene's Test for Equality of Varianc		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig	t	d	Sig. (2-tailed	Mean Difference	Std. Error Difference	Lower	Upper
Household Adaptive Capacity Index (No External Factors)	Equal variances assumed	1.910	.168	2.965	401	.003	1.73077	.58364	.58340	2.87814
	Equal variances not assumed			2.798	109.598	.006	1.73077	.61851	.50498	2.95656

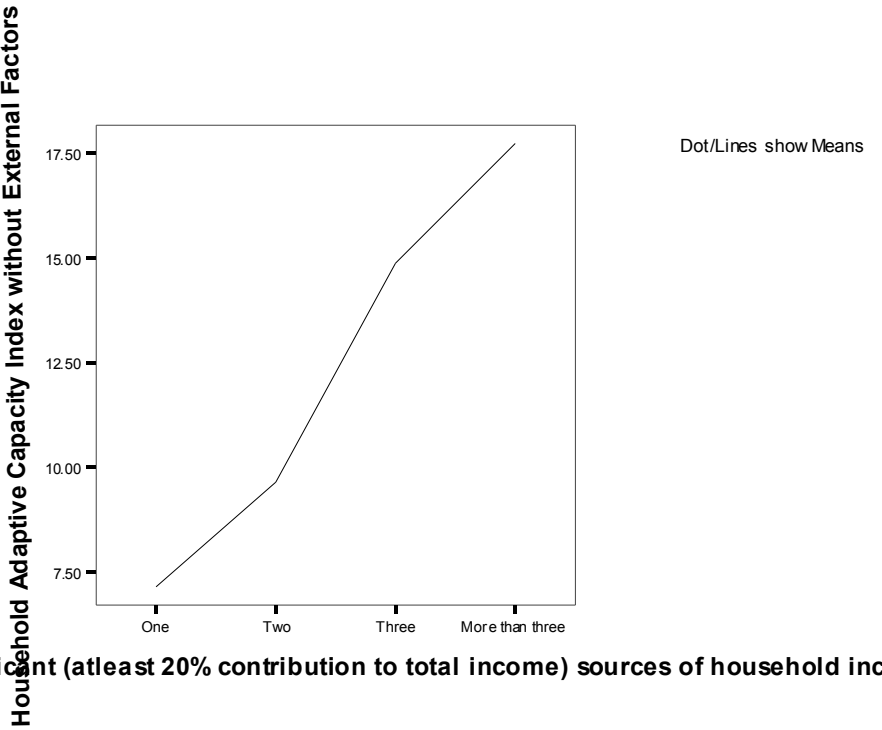
Interpretation: The results of using the Independent Samples T-Test in SPSS to compare the mean HACIs of the two sub-samples of households, that is, one of loanee households = $\overline{x}_1$ and that of non-loanee households = $\overline{x}_2$ in the area of study showed that there was a significant difference between the means (significance = 0.003; for a two tailed test).

Looking at this result together with the mean HACIs from the two sub-samples (loanee sub-sample, $\overline{x}_1$ = 11.04 and non-loanee sub-sample $\overline{x}_2$ = 9.31, the study rejected the null hypothesis and accepted the alternative one which stated that the use of credit (loans) positively influences the HACI.

5.3.3 Diversification and the HACI

As already explained, households with more than one source of income were generally observed to be capable of better adapting to environmental stress. The graph below roughly shows the generally positive relationship between income diversification and HACI.

Figure 59: HACI and Income Diversification



Applying the independent samples test to the relationship between income diversification and household adaptability (HACI) yielded the information in tables 60 and 61. This form of analysis of the relationship between the HACI and income diversification must however be

interpreted with a lot of caution since the latter plays a very important role in the structure of the former.

Table 60: Group Statistics (Income Diversification)

	Number of Significant Income Sources	N	Mean	Std. Deviation	Std. Error Mean
Household Adaptive Capacity Index without External Factors	One income source	132	7.1667	3.50391	.30498
	2 or more income sources	271	10.8487	4.70177	.28561

The mean HACI of households with more than one sources of income was 10.84 compared to that of households with only one source of income which was 7.17. In the following table, the t-test for significance (equal variance not assumed) at a 95% confidence interval (two-tailed) shows a 0.000 level of significance thereby pointing towards a strong influence of income diversification on household adaptability.

Table 61: Independent Samples Test (Income Diversification)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Household Adaptive Capacity Index (No External Factors)	Equal variances assumed	9.877	.002	-7.980	401	.000	-3.68204	.46138	-4.58907	-2.77501
	Equal variances not assumed			-8.812	336.112	.000	-3.68204	.41783	-4.50394	-2.86014

Table 62: Cross Tabulation – Needed Actions for Adaptation * Household Literacy

		Household literacy level(% of read + read & write) members				Total
		Totally illiterate	Low - <50%	Medium - 50 - 75 %	High - >75%	
Ideal action worth taking to ensure household fully adapts to environmental problems	Training	8	11	34	47	100
	Alternative livelihood source	14	48	81	118	261
	Tree planting	0	4	0	6	10
	Other - Material assistance e.g. food	8	12	4	8	32
Total		30	75	119	179	403

When asked about actions that needed to be taken to enhance adaptability, 64 per cent of the respondents prioritised alternative livelihood sources (cross tabulations presented in table 62). A similar cross-tabulation was also done for the desired improvements and the occupation of household head in order to pick up any differences in desires due to occupation. Here, as if to signal a burning desire to diversify or exit from farming, it was found out that a majority (63 per cent) of the households preferred alternative sources of livelihood as the ideal course of action that could enhance their adaptability. This observation can be seen in table 63 which presents a cross tabulation of preferred courses of actions and occupation of household head.

Table 63: Cross Tabulation – Preferred Adaptation Action * Household Head's Occupation

		Main occupation of the household head as seen by time spent and income generated			
		Farmer	Employee/Worker	Non-agricultural self employment/employer	Total
Ideal action worth taking to ensure household fully adapts to environmental problems	Training	73	23	4	100
	Alternative livelihood source	189	50	22	261
	Tree planting	8	0	2	10
	Other - Material assistance e.g. food	30	0	2	32
Total		300	73	30	403

5.4 Towards enhanced Adaptability: Factors and Strategies

Process of adaptation decision making

Observing that current knowledge on adaptation and adaptive capacity is insufficient for reliable prediction of adaptations and also insufficient for rigorous evaluation of planned adaptation options as well as measures and policies of governments, Smit *et al*., (2001) argued that more research is needed on the dynamics of adaptation in human systems, the process of adaptation decision making, conditions that stimulate or constrain adaptation and the role of non-climatic factors. This dissertation makes the following observations in relation to adaptation decision making.

In Kakamega district, the process of decision making on adaptation actions was, in most cases led by the household head and these decisions once taken had to be implemented by all the members of the household. Even though wives ran the households on a day to day basis they

reserved the position of household heads for their husbands (who also strongly claimed and defended the position). The decision making process on the adaptation actions to take in face of shocks and environmental problems was observed to be rarely democratic, that is, in most cases, the husbands (household heads) decided unilaterally and the rest had to work with his (her) choice. However, smaller younger households appeared to consult more within the households before final decisions were made thereby benefiting from a broader support for the adaptation actions. Moreover, once a decision had been made, inertia crept in with households sticking with the made decisions for long time periods regardless of whether the actions were proving to be effective or not.

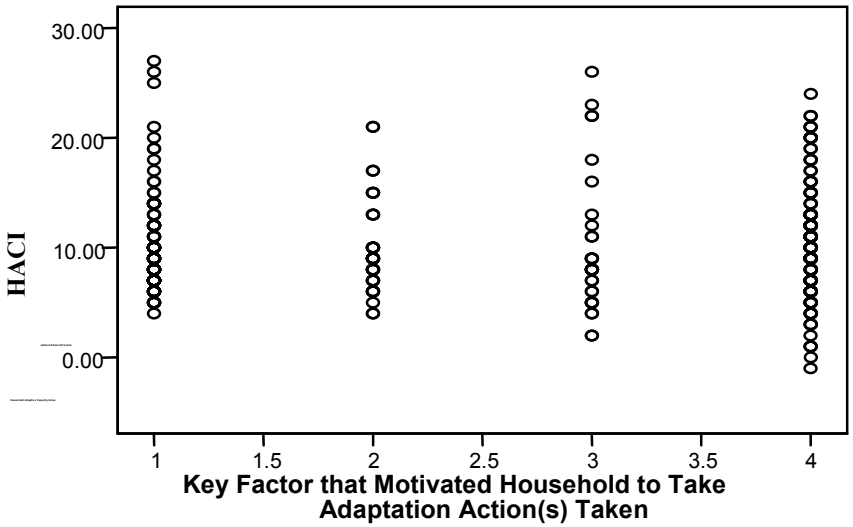
The commitment of the household head was observed to be a key determining factor as was his or her level of information. The household head relied on information from public meetings (*barazas*), radio and awareness creators regarding prevalent phenomena affecting lives in the communities and available options. Own personal initiative and demonstration effect from neighbours were mentioned as the leading factors behind the adaptation actions taken by households (particularly those whose actions had yielded some success). This information is presented in table 64. A sizable group of households preferred to first observe what others were doing in response to the prevalent phenomena and the potential benefits of such actions (see figure 60). This behaviour was driven by the need to minimise risks. If immediate benefits could be seen or where public or NGO incentives were associated with the adoption of certain strategies, then the household head mobilised other household members to implement that particular strategy as he or she had seen from the other residents or heard from NGOs and public agencies. As a matter of fact, once the household head had decided on a particular action or strategy, the household members worked towards the chosen end.

Table 64: Cross Tabulation - Motivator for Adaptation * Impacts of Actions

		Observed impacts due to actions taken against environmental problems		
		No impact yet	Some impact	Total
Key factor that motivated household to take the adaptation action(s) taken	Demonstration effect from neighbours/acquaintances	34	93	127
	Easy availability of tree seedlings	6	32	38
	NGO/govt/other person's encouragement	12	20	32
	Purely own initiative	26	129	155
Total		78	274	352

Most households seemed to be aware of the fact that the success of their adaptation actions largely depended on their personal initiative (see figure 60). It was observed that the level of information or awareness of environmental stress and possible response options on the part of household heads tended to promote personal initiative (taking adaptation actions).

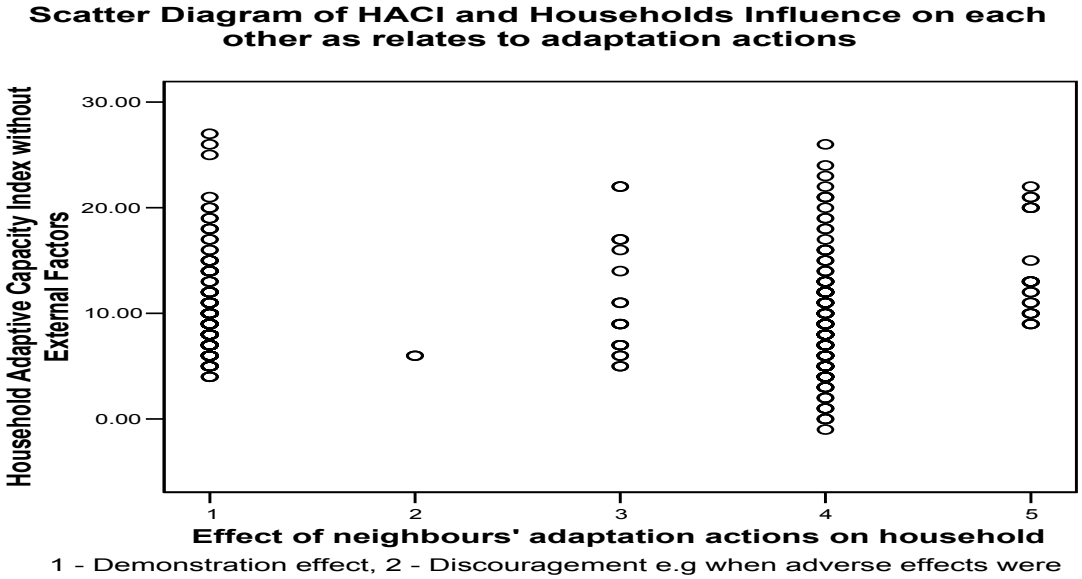
Figure 60: Scatter Diagram of HACI and Adaptation Motivating Factors



1 - demonstration effect, 2 - availability of seedlings, 3 - encouragement from govt/NGO/other, 4 - Own initiative

From figures 60 and 61, which show key adaptation motivating factors and households' own views of how their neighbours' actions influenced them respectively, one can conclude that demonstration effect is of significance in adaptation.

Figure 61: Influence of Neighbours' Actions on Household Adaptation



1 - Demonstration effect, 2 - Discouragement e.g when adverse effects were witnessed, 3 - Motivation to also do something 4 - No effect, 5 - Copied from us

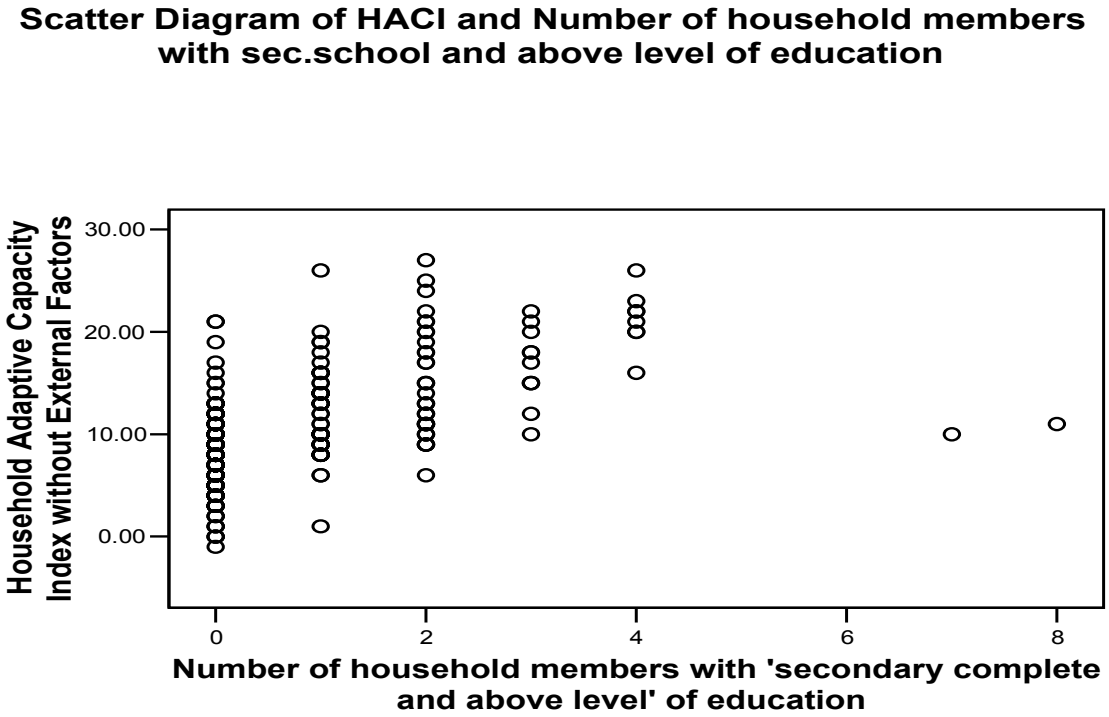
Another aspect of importance in the area of study is that a difference was visible between the strategies open to female headed households and those of male headed ones since cultural or customary provisions like those barring women from planting trees or those restricting female ownership of land tended to exclude female headed households from some strategies. Women staying alone strongly lamented about the cultural hindrances and prevalent traditional belief systems when choosing to plant trees since women were not permitted by traditions to plant trees. Such women had either to engage/hire men to plant the trees for them or disregard tradition and invite tongue-lashing besides the threat that the trees could be uprooted at night. The significant influence of traditional beliefs was also observed through a strong belief in witchcraft which was reported to be stifling general development in some areas like Shamiloli in Shinyalu division. In Shamiloli, the only secondary school leaver was believed to have gone mad allegedly due to witchcraft. However, with the recently promulgated constitution improving women's right to property and NGOs persuading residents to abandon retrogressive customs and traditions, the process of adaptation was set to receive some boost.

Strategies and Factors Associated with high HACIs

In summary, adaptation strategies associated with high HACI included taking up off-farm employment (income diversification), forestation, non-farm business activities, optimal input use and use of credit. The factors associated with high HACI included: Engagement in enterprises, a secondary school level of education for at least a household member and the possession of non-livestock and livestock assets. These observations are supported by the scatter diagram in figure 62.

Among the conditions that promote adaptation were government/NGO actions to raise awareness, demonstration effect from neighbours or acquaintances and availability of trees seedlings. Tree planting was the most frequently adopted action but the scale and survival of trees differed greatly. A reforestation-limiting factor was observed in that 63.8 per cent of the respondents reported that they would consider planting more trees only if they had access to more land. Moreover, farmers complained that trees planted on plot boundaries disturbed crops yet when they planted trees within their homesteads, livestock destruction plagued their efforts. With these observations, one can expect that efforts to promote reforestation could be faced by low elasticity.

Figure 62: HACI and Educational Attainment in Households



Previous research in the area suggests that people with sec. school education are unlikely to be trapped in poverty (Mwamba, 2007)

6.0 Conclusion and Recommendations

This dissertation with its underlying household survey had the objectives of:

- advancing understanding of the vulnerability and adaptive capacity of rural households to environmental and climatic changes;
- developing a robust household adaptive capacity index (HACI);
- finding out the key stages in the adaptation decision making process;
- elucidating the adaptation efforts exhibited by the rural households in response to declines in natural resources and climate change;
- pointing out strategies associated with higher household adaptive capacities; and
- identifying the factors associated with higher household adaptive capacities.

These objectives have been achieved as presented in chapters two, three, four and five. Empirical support was obtained confirming that households and individuals show more vulnerability to extremes rather than average annual changes and that vulnerability, just like adaptability, is dynamic. Among the causes and drivers of vulnerability observed include: Degradation of the environment, variability in weather and climatic conditions as well as shocks such as droughts and floods. Other drivers include low levels of livelihood, low adaptive capacity/weakened resilience, institutional weaknesses, inadequate access to information, weak social capital, and inequality in the distribution of resources and opportunities (social justice issues).

The household survey showed that loss of vegetation[44], land degradation[45] and erratic weather patterns (varying climatic patterns) are the key issues of negative environmental changes (environmental stress) with which rural households in Kakamega district had had to contend or adapt to for quite some time preceding the survey. Whereas the rural households were also affected by the overall global climate change to varying scales, they could more easily and

[44] This dissertation made observations concurring with Ogunlade *et al.*, (2003) who observed that tree clearing for agricultural reasons is a primary cause of deforestation and soil erosion with the practice becoming an essential act to meet the food needs of rapidly growing populations. However, this dissertation found out that tree cutting for timber, fuel and charcoal (for sale) have risen to play a more significant role within rural households. With high population growth, arable land has been subdivided and cultivated leaving very little if any space for trees.

[45] Like Ogunlade *et al* (2003) espoused, previous methods of leaving land fallow for long periods and maintaining the balance between human activity and natural vegetation – have been shattered and fallow periods are steadily diminishing, thwarting the proper regeneration of agro-ecosystems. In the area of study, the practice of leaving land fallow has almost vanished in totality.

readily identify with and respond to the local environmental changes whose dynamics they had directly experienced. The poor rural farmers readily recounted the increasing incidences when the rains delayed or when amounts of rainfall deviated from normal and the trends in deterioration of their land while the cattle keepers knew exactly the growing difficulty in finding pasture for their livestock just as the rural women were fully aware of the growing challenges in finding adequate firewood. Negative shocks such as increases in prices of farm inputs and those of consumer products besides diseases further compounded the vulnerable situations in which the rural households find themselves.

In terms of coping strategies implemented by the rural households, the dissertation made observations concurring with those of other authors in that strategies commonly used by households for coping with vulnerability generally included social capital, income raising and consumption modifying strategies (Moser, 1998; Mohanty, 2007). Households in the area of study coped by, among other things, reducing consumption (referred to by the respondents as 'tightening their belts', assistance/borrowing from family, friends, contacts and relatives as well as sale of household assets[46]. At a slightly higher level (beyond coping strategies) the set of adaptation and mitigation strategies used by rural households in the area of study included planting of trees, diversification of sources of income, borrowing, improved use of farm inputs, migration and mutual help among relatives. These findings were in partial agreement with those of Reid & Vogel (2006) who carried out a study in the Muden area of KwaZulu-Natal in South Africa and found out that a mix of adaptation strategies (to secure livelihoods) for some of the cultivators in the area included outside employment/temporary migration and reciprocal obligation.

The dissertation has put forward a household adaptive capacity index (HACI) which has been applied in the assessment of the internal capacities of rural households to adapt to negative environmental changes (environmental stress). The HACI is a function of economic wellbeing & stability, dependency burden, interconnectivity in higher level processes, susceptibility to environmental changes, housing quality, awareness level & actions taken as well as the prevalent institutional & infrastructural environment. It has been argued that the livelihood

[46] On household asset dynamics, Muyanga *et al* (2010) found out that among households in Kenya who reported a significant decline in asset wealth over time, roughly half experienced unexpected shocks, such as premature death and chronic illness. These households reported spending 22 per cent of their annual incomes and 47 per cent of their assets on medicines and care-giving.

resources and response options of the poor are usually narrower and more climate-sensitive than the non-poor (African Development Bank *et al*., 2003) and also that the most pressing challenge is to strengthen the social, economic and environmental resilience of the poorest and the most vulnerable against climate change and variability (Fischer *et al*., 2002). The dissertation's contribution in form of an assessment tool is an important step forward because, among other things, the application of the HACI will henceforth help answer the question as to why households facing the same risk may not be equally vulnerable. The HACI will also help to identify households with the least adaptive capacities thereby facilitating proper targeting of such households using the most effective sets of strategies.

Hypothesis testing using the HACI showed that the use of farm inputs positively and significantly influences household adaptive capacity as does the use of credit. Of specific importance is the outcome relating to the use of credit as it confirms Leichenko and O'Brien's (2002) postulation that credit and farm inputs enhance adaptation.These findings on input and credit use also supply reassuring knowledge to households that these tools are still useful even under the conditions of high incidence of negative shocks that has tended to shake households' confidence in these two tools (at least in the area of study).

A closer look at the households with the lowest adaptive capacity indices *vis a vis* those with the highest ones suggested that the profitable use of loans; access to information via networks; accumulation and use of capital goods; diversification into high income activities; surplus agricultural production; and migration (that is coupled with remittances) account for a large portion of the differences in adaptive capacity between the two groups. The dissertation established that, besides primarily engaging in peasant farming, households with low adaptive capacities also exhibited low levels of literacy as well as low levels of accumulation and use of capital goods. Some of these findings concur with the postulations of other authors that poverty (low levels of living) is linked to a low capacity to adapt to environmental stress and climatic changes (Kelly & Adger, 2000). Reid & Vogel (2006) also pointed out that widespread poverty and low education levels among other things, leads to a low adaptive capacity.

With the HACI put forward in this dissertation and the assessment of inter-household differences carried out here, future assessment of micro level adaptive capacity and examination of feasible adaptations may find theoretical, methodological and empirical

grounds with or against which they can check projects during these tricky times of climate change. At a more practical level, policy makers, public agencies, NGOs and other stakeholders can rely on the HACI to help identify rural households which cannot adapt independently and then efficiently target the same with effective actions especially in view of the following IPCC (2007) findings and/or projections:

a) In the Sahelian region of Africa, warmer and drier conditions have led to a reduced length of growing season with detrimental effects on crops. In Southern Africa, longer dry seasons and more uncertain rainfall are prompting adaptation measures.

b) Projections for food fibre and forest products: Crop productivity is projected to increase slightly at mid to high latitudes for local mean temperature increases of up to 1 – 3°C depending on the crop, and then decrease beyond that in some regions. At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1 - 2°C), which would increase the risk of hunger.

c) Health: Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through increases in malnutrition and consequent disorders, with implications for child growth and development among other things. Climate change is expected to have some mixed effects, such as a decrease or increase in the range and transmission potential of malaria in Africa. Critically important will be factors that directly shape the health of populations such as education, health care, public health initiatives and infrastructure and economic development.

At the academic level, researchers undertaking cross-household comparison in the developing and less developed countries would also find the output in this dissertation useful in view of the empirical support supplied for various postulations and the assessment tool (HACI). As an example, the HACI contributes towards the understanding of dynamic vulnerability, that is, the extent to which environmental and economic changes influence the capacity of regions, sectors, ecosystems and social groups to respond to various types of natural and socio-economic shocks (Leichenko & O'Brien - 2002). By recording and examining changes in HACIs of households over time one can gain insight into the dynamic aspect of vulnerability which, according to Adger and Kelly (1999) is more important as compared to a snapshot

measure of vulnerability taken at a particular point in time. This is possible given the fact that vulnerability is a function of adaptive capacity.

In relation to adaptation enhancement strategies, the dissertation emphasises that access to finance (credit) and/or assets is a necessary though not a sufficient condition to enhance adaptability and reduce vulnerability. Like Moser (1998) espoused, a capacity to manage the assets and transform them into income, food or basic necessities is also required. This necessitates the effective training of household members in areas such as finance and resource management. The appropriate type of training would be that which enables household members to generate income, food and other benefits from their assets or loans and diversify their income sources so as to avoid relying heavily on environment/climate sensitive resources. Particularly, micro-finance institutions[47] serving rural households would achieve much better results if they better integrate effective training in business skills in their set of products.

[47] Microfinance institutions have tended to focus more in credit provision while assuming that clients are knowledgeable in financial management, business processes and investment decision making. Experience from various parts of the world has delivered a fairly different picture. A brief assessment of the reasons given by for the widespread fear of credit by respondents in the area of study points an accusing finger at microfinance institutions for neglecting financial literacy. In the area of study, credit providers included a set of NGOs, Kenya Women Finance Trust, Equity Bank and community based organisations. Besides credit provision, NGOs were also engaged in awareness creation on Malaria control, anti HIV/AIDS campaigns, environmental protection, protection of springs and sensitisation on agri-business but efforts put towards improving financial literacy were evidently inadequate. On a positive note, the NGOs were observed to be playing key roles in bridging deficits in provision of health services and therefore helping boost household adaptability.

Recommendations for Policy and Action

A number of developing and transition economies possess unique characteristics and call for appropriate strategies when it comes to improving adaptation or reducing the impacts of negative environmental and climatic changes. Improving household adaptive capacity should be considered as being one part of a set of strategies to address the related phenomena of environmental and climatic changes especially among rural households. Other core aspects on which macro level actors should work on include the improvement of forest cover and the adoption of environmentally friendly production processes. Actors at the micro, meso and macro levels have to complement each other's efforts and work in a coordinated way towards the ultimate goal of securing the best possible quality of life in a sustainable way. Generally speaking, each (developing) country would be well advised to chart its own development path (growth trajectory), not necessarily identical to that used by the industrialized European, American and Asian countries[48] but rather, ones which are sustainable and compatible with natural resource endowments in the country or region in question.

When assessing the set of feasible strategies to address environmental and climatic changes, it is worth observing that many developing and less developed African countries are still grappling with the challenges brought about by negative ethnicity in their attempt to establish functional institutions within the process of democratization. In many African countries like Kenya, the need to protect the environment has been acknowledged as being an important one but attempts at environmental protection have often been thwarted by short-term interests, corruption, limited resources in face of numerous competing needs (for instance, drought response, improving food production, poverty alleviation, health provision, infrastructure development, job creation, investment in education and training). As a result, the resources allocated to environmental programs by developing country governments are often too inadequate to meet the necessary threshold for meaningful impact.

The fact that evolving democracies such as those in Africa frequently witness politicians making environmentally harmful promises or decisions with the hope of winning votes presents a further hindrance to environmental protection (reversing negative environmental changes). Poor households, whose immediate need is survival, often buy such 'cheap' and

[48] The oil powered industrialization process and consumption patterns spear-headed by industrialists is considerably responsible for the current damage to key common resources of the globe such as air, climate and water resources.

short-sighted promises and support such politicians tooth and nail. Such was the case in Kenya regarding the recent restoration of the Mau forest (2008 – 2012) and the on-off games with non-resident cultivation in public forest over the past (politicians previously enticed voters with permission to cultivate within forests at a high cost to vegetation cover). A known weakness of democracy is that the most popular often wins the contest even though he or she may not necessarily be the best in terms of sustainable development. Given that many African countries are characterized by high poverty levels and that negative ethnicity[49] frequently clouds rational judgment, poor and short-sighted leadership (which is often disadvantageous to the environment) has remained a widespread feature in the continent. Moreover, in countries with weak institutions (associated with poor implementation of policies and weaknesses in the rule of law), parastatals have had a poor record in managing public resources[50] thanks to inefficiency, favouritism, corruption and political interferences among other things.

Given such challenges, this dissertation considers and proposes a three-pronged approach to addressing vulnerabilities arising out of the related phenomena of environmental and climatic changes especially in developing and less developed countries. The actions constituting this three-pronged approach towards enhanced adaptation and mitigation are explained as follows:

Enhancement of household adaptive capacity: This should primarily target households with low HACIs which are also often low income households. Experience by the author among rural poor household in Kakamega district of Kenya over the period 2005 – 2010 shows that this group of households achieve very little while implementing reforestation (on-farm cultivation of forest species). Among other things, a majority of the low income households often had small pieces of land, had low levels of education and information, were faced with a higher than average incidence of negative shocks (human and livestock diseases as well as deaths) and/or often had limited access to resources necessary to meaningfully implement reforestation projects. On-farm cultivation of forest species was limited by the fact

[49] Many Post-colonial African countries have principally remained state-nations struggling to form nation-states. A majority are composed of ethnic groups with distinct cultures. Many individuals view themselves as belonging to their ethnic groups first and then the country coming second. This situation often clouds and distorts not only the process of electing national leaders but also the commitment to national projects such as reforestation.

[50] The performance of parastatals and state corporations however depends on the management. In the Kakamega forest of Kenya for example, the parts/segments of the forest managed by the stricter Kenya Wildlife Services (KWS) was observed to be better protected than that managed by the Kenya Forest Department. This is partially because the former has better resisted political interference than the latter. Besides, KWS has had better trained rangers.

that population pressure had led to subdivision of land into very small parcels per household and the small landholders also complained that trees prevented their food crops from growing well thus leading to poor farm yields. With limited resources to effectively deal with ill-health or other negative shocks, low income households were constantly in a firefighting mode and were (logically) preoccupied with the struggle for survival[51]even if this meant harvesting very young trees. Some had to diversify into low-return off-farm activities like bicycle taxi thereby not only depriving on-farm activities of the necessary labour but also leading to inadequate commitment to reforestation projects. A majority of such low-income households is highly likely to abandon reforestation projects sooner rather than later or even cut the trees before maturity and fail to plant others. Being poor, such households consider themselves as having very little to lose (in terms of reputation and material possessions) even if they abandon their previous commitments hence present a difficulty in enforcing long-term reforestation agreements.

Having found out that the use of credit positively influence the HACI, as does the regular and optimal use of farm inputs (like fertilizer and better seeds), this dissertation argues the case for improved use of these options among the low income households. However, it is worth stressing that observation from the Kakamega area of study shows that the use of credit is only a necessary but not a sufficient condition. Improved access to credit needs to be accompanied by such business development services as training in business skills (such as profit & loss calculation, budgeting, cash management, value addition, marketing and investment). These business development services could improve repayment besides developing micro, small and medium enterprises (especially cottage industries) with considerable multiplier effects. Among other things, this steps hold significant potential in persuading households with low HACIs to invest in higher return off-farm activities (as opposed to the low return ones like bicycle taxi) as well as in more productive farming.

Given the small household landholding (thanks to population pressure), better use of farm inputs (like fertilizer and improved seeds) realized through improved access to and management of credit could be complemented by training in (higher value) horticulture production. Despite the traditional emphasis on the planting of maize and beans which are

[51] As mentioned elsewhere, the field research was carried within the multi-disciplinary BIOTA-East Africa research project. At project conclusion, it was evident that low income households were less committed to forest conservation if their immediate needs were at stake.

more sensitive to weather changes and have relatively higher moisture requirements, it has been observed that some horticultural crops require less moisture and pay better. Training on the appropriate production methods of such food items like tomatoes, onions, kale, traditional vegetables and passion fruit[52] are likely to show better (perhaps optimal) results for small landholders in terms of income and nutrition[53]. Where possible, horticultural farming could be complemented with poultry or goat keeping and the households trained in making compost manure out of the poultry and goat wastes to improve soil fertility. At higher levels, the promotion of simple irrigation and better documentation as well as dissemination of local weather information could yield further dividends as could skill development in areas like information and communication technology[54].

Observations during field research carried out for this dissertation suggest that sustained adequate public expenditure on health, training and infrastructure as well as improved governance featuring efficient institutions hold significant potential for enhancing household adaptability. Kenyan public expenditure via the constituency development fund, women fund, youth fund, subsidised education, subsidised health care and subsidised farm inputs were positively mentioned by respondents as aspects that had improved their ability to cope with environmental challenges. It was however apparent that great inefficiencies existed. A training gap was evidently hindering the full realisation of the objectives of such initiatives as the youth and women funds since a majority of the targeted individuals lacked knowledge on business/project proposal writing as well as basic management skills thereby leading to fear of loans (people rather avoided that which they could not handle).

Protection of the environment by improving forest cover: With the benefit of experience in Kakamega district, this approach stands a better chance of delivering the desired benefits if it is implemented among medium and high income households. Now, this appears

[52] The author observed that farmers in the neighbouring Nandi and Kitale areas were already reporting tremendous success with passion fruit over the 2010 – 2011 periods.

[53] With income from horticulture, items like food, timber and cleaner energy for cooking can be purchased from the local and regional markets.

[54] Experience in Kakamega district shows that remittances from emigrated household members play a significant role in coping with negative shocks and therefore helps adaptation. When household members emigrate with low skills, they tend to take long before finding paying jobs in their points of destination (mostly urban centers) and if they do, the jobs are often low paying leading to low amounts of remittances. Training on areas such as information and communication technology or welding will ensure that emigrating household members have better skills so as to get better paying jobs faster and be in a position to remit higher amounts of money to support the adaptation of parent households. Training done at village level is likely to be more cost effective as trainees need not pay for such costs as transportation or rent during the training since they stay at their own ancestral homes.

contradictory since medium and high income households are likely to have higher household adaptive capacity indices, in which case they may be expected to be more capable of independent adaptation (less vulnerable). However, keeping the greater objective in mind lets the semblance of contradiction quickly disappear. If the stated objective is to reduce negative environmental and climatic changes (mitigation) thereby securing crucial supplies of dwindling natural resource commodities (which are essentially common goods), then it makes sense to direct this approach to the group of households or persons capable of best executing it to fruition for the benefit of all.

The limitations of low income households when it comes to on-farm cultivation of forest species (reforestation) have already been discussed under the first course of action (enhancement of household adaptive capacity). Those limitations observed among low income households fade to a great extent when dealing with medium and high income households. Members of households falling in the medium and high income group household are often better informed (also better educated) and therefore are bound to better understand the end objectives of the reforestation projects thereby improving their commitment and willingness to respect agreements.

Experience from Kakamega district shows that such households experienced fewer negative shocks (some had independently planted more than ten trees which were growing). With their immediate basic needs already provided for, persons from medium and high income households are better capable of committing themselves to longer term as well as secondary and tertiary issues of interest. Such households are better placed to commit part of their land (often have a higher-than average landholding) to longer term on-farm cultivation of forest species or even invest some of their money in acquiring land specifically for reforestation projects given clearly stipulated benefits (in an approach similar to the carbon trading framework). In developing countries like Kenya, encroachment into public land by poorer households has a history of being encouraged by politicians hence defeating the original objectives. This makes the private approach more attractive. Where public institutions like schools and colleges are involved, a water-tight arrangement regarding holders of title deeds and authority over the reforested lands must be made.

Private benefits remain the greatest material source of motivation to mankind. With well designed agreements, governments, international organizations, non-governmental

organizations such as promoters of green projects (for instance the clean development mechanism – CDM) should better motivate medium and high income households (or even institutions like schools and colleges) to invest in long-term sustainable forestry projects (complete with tree nurseries and natural complements like bee-keeping), for these promise better success rates. Part of such an arrangement should be an agreement that allows only the sustainable harvesting of mature trees. Additionally, there should be effective enforcement procedures and well spelt out repercussions. In this way, governments and organizations will effectively leverage on the assets of medium and high income households (and also possibly institutions, businesses and organizations) to secure improved supplies of natural resource commodities (protected/clean environments with carbon sinks) in a win-win fashion. Apart from a protected and cleaner environment (improved supply of a common good) due to improved forest cover through the efforts of medium and high-income households, the lower income households which shall be using the alternative approach of enhancement of household adaptive capacity should be capable of purchasing the sustainably produced timber to meet their needs. In the author's view, such an arrangement would be superior to the forms of aid which are often offered to households in some parts of the developing world and would achieve much more than any kind of short-term humanitarian assistance[55].

Adoption of environmentally friendly production methods or processes: This is largely a macro and meso level issue (and therefore lies beyond the focus of this dissertation). However, with improved incomes from the outlined options for low income households and medium & high income ones, the transition away from wood fuel (commonly used in homes) towards more environmental friendly sources stand a better chance of succeeding given the right policies in place. In that way, households would be making part of the contribution due from them in order to adapt to and reduce the negative environmental and climatic changes.

As Ogunlade *et al* (*ibid*) observe, many developing country governments in Africa have tended to pay less attention to the reduction of green house gas emissions due to their

[55] Debate around the topic of aid ineffectiveness shows that poorly planned aid and/or humanitarian assistance tends to create dependence and precipitates irresponsibility (victims/aid beneficiaries leaving other people to care of their affairs). Aid or humanitarian assistance has a potential of distorting rational decision making at the household level. Given the already high level of population growth leading to uneconomical sub-division of land, conflicts over resources and, in some cases, hunger, responsible aid/humanitarian assistance should send the right message to households namely: that an optimal quality of life for household members is only possible if parents/citizens/victims take their future into their hands and proactively design the same.

perception that they have more immediate problems. The commonly mentioned argument that Africa contributes least to green house gas emissions has been an additional excuse used by African governments for not working on GHG emission reduction plans. However, the earlier African governments adopt clean production processes, the better their contribution towards dealing with the environmental and climatic change phenomena is likely to be. Alongside actions against global climate change at the international level, country level actors would also do well to institute feasible long term solutions along the lines of improved weather forecasts, adoption of clean production processes as soon as possible, better protection and management of water catchment areas and use of well managed irrigation projects. These areas hold immense potential to the long term enhancement of adaptation and mitigation for the benefit of households as well as whole regions. In these ways, developing and least developed countries can adopt sustainable growth paths and prevent some challenges which appear to lie ahead of them given the current state of things.

Table 65 presents a tabular summary of the actions and actors in the above described three-pronged approach towards enhanced household adaptability, generally improved adaptation and mitigation. Overall, developing and less developed country governments will have to firmly and clearly define the sustainable development path and persuade all persons within their territories to move in the desirable direction. Quite often, good intentions, programmes and projects fall due to poor leadership rather than inadequate financing and adaptation projects are no exception.

Table 65: Feasible Strategies against Negative Environmental & Climatic Changes

Overall objective: Reduce negative environmental and climatic changes		
Approach	**Target**	**Activity**
Enhancement of household adaptive capacity	Households with low HACI	Undergo training provided by business development services providers (book keeping, marketing, value addition, investment).
		Empowered to borrow and invest in farming (purchase fertilizer and seeds).
		Undergo training on horticultural production, poultry and goat husbandry.
		Invest in poultry and goats.
		Learn proper composting and use poultry and goat waste on small plots of crops like kale, tomatoes, onions, traditional vegetables and passion fruit.
		Younger household members to undergo training at local level in information and communication technology and metal work according to demand in job market.
		Use simple irrigation techniques for horticulture.
Reforestation or on-farm cultivation of forest species	Medium and high income households (often also the ones with higher HACI)	Purchase or dedicate land to indegenous or endemic forest species.
		Integrate tree nurseries and marketable climbers like *Mondia whitey* (Mukhombero) and passion fruit farming into the planted forest.
		Integrate bee keeping into the planted forests.
		Sustainably harvest forest products and consistently improve so as to contribute towards improved environment.
GHG emission reduction	All	Formulation and implementation of policies to encourage use of environmentally friendly production processes.
		Establish infrastructure such as appropriate power lines for transmission of clean energy to and from households, institutions and businesses (solar power can be harnessed on roofs of buildings in institutions or roofs of individual households).
		Invest in clean energy generation and/or switch to use of clean energy sources.

Appendix

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2. Management of Forests in Kenya and Government Actions in Kakamega Forest

By the year 2005, forests occupied only 2.8 per cent of Kenya's total land area (565, 600 km^2) even though there was a high dependence on forests for wood and non-wood products. Kenyan forests have been managed by different management regimes and have had different legal status. Majority of the closed canopy forests are gazetted as forest reserves under the Forestry Act (Cap.385 of the Laws of Kenya) and are managed by the Forest Department (FD) under the Ministry of Environment and Natural Resources (MENR). Some closed canopy forests are gazetted as national parks and national reserves and are managed by the Kenya Wildlife Service (KWS). The FD and KWS have entered into a memorandum of understanding to oversee the management of forests whose biodiversity is threatened and Kakamega forest (which is currently approx. 140 km^2 – Glenday, 2006) is one such example. An estimated 100, 000 ha of forests in Kenya are under Trust Land, managed by the Ministry of Local Government through the local authorities which hold the land in trust for the people. Some undocumented areas of indigenous forests are also under private ownership.

Kakamega Forest is not a single forest block but rather consists of a main block surrounded by several fragments with distinct names. The name Kakamega forest as herein used refers to the main block as well as the fragments of the patch of Kenya's Guineo-Congolean rain forest that is rich in flora and fauna, which originally spanned from west and central Africa with its easternmost edge lying in western Kenya. From the physical establishment of the forest boundary around 1908 - 1910, there have been boundary modifications in 1912 - 1913 and 1929 - 1932. Between 1910 and 1920, there was opposition to any sort of control of the forest by the government. At that time, Kakamega forest was managed by the local people through their village elders who were responsible to the local native council. In 1931, the FD took over the management of the forest amidst very strong objection by the local people who wished to retain control. Despite the local opposition, Kakamega forest was gazetted as a trust land forest on 13th February 1933 meaning that, although the forest would remain the property of the local people, the government would manage it on their behalf with the goal of improving and maximising its economic benefits. A few customary rights of the local people to the forest were reinstated by special rules issued in 1959 and 1964 allowing the local residents the right to use the forest for grazing, cultivation and collection of firewood. In 1964, the forest was declared a central government forest implying that the forest thereafter

belonged not only to the local people but to the nation as a whole. A tabular summary of the history of management of Kakamega forest is provided below.

Summary of key historical events related to the Kakamega Forest

Date/Period/Year	Actions/Developments affecting Kakamega Forest
Early 1900s	Kaimosi fragment under management of the Quakers Church Mission.
1908 - 1910	Physical establishment of forest boundary.
1912 -1913	Modification of boundary.
1929 - 1932	Modification of boundary.
1931	Takeover of forest management by the forest department.
13th February, 1933	Gazetting of forest as trust forest land.
1940s	Introduction of the non-resident Cultivation.
1959	Issuance of special rules reinstating a few customary rights.
1964	Issuance of special rules reinstating a few customary rights.
1964	Declaration of forest as central government forest.
1984	Presidential directive banning conversion of indigenous forest to plantation.
1985	KWS management regime sets in certain parts.
1986	Creation of the Kakamega National Reserve through the official excision of 2 areas (Kisere & Buyangu).
1985 - 1987	Banning of Non-resident cultivation in most of the forest except in the part managed by the forest department.
1988	Presidential directive banning the cutting of indigenous forest trees.
1991	Memorandum of understanding between the forest department and the Kenya Wildlife Service for closer co-operation
1997	Surrounding poverty and landlessness led to the temporary reintroduction of 'strict' Non-Resident Cultivation.
2004	Complete ban on Non-Resident cultivation in all indigenous forests.

(Source: Mwamba, 2007)

In 1986, two areas were officially excised from the forest to create the Kakamega National Reserve encompassing the Kisere fragment and the north-western part of the main forest

block, also called Buyangu – both of which were until the time of this work, managed by the KWS as a national reserve. This was done to protect and preserve the less disturbed area that is representative of the Kakamega Forest.

The southern part of the main forest block and several minor fragments (such as Malava) are managed by the forest department. The Kaimosi fragment in the south-western side (part of which has been cleared for the construction of a conglomerate of a number of educational institutions) of the main block has since early 1900 been managed by the Quakers Church Mission. Whereas many of the rules are not strictly enforced by the FD, the KWS by contrast very strictly prohibits extraction of forest products in the national reserve.

Guthiga and Mburu (2006) explain that there are two main paradigms of biodiversity conservation: The traditional fortress conservation (fence and fine) and the incentive-induced conservation which entails more of a decentralised management. The KWS management regime in Kakamega forest which follows more of a fortress conservation paradigm was found to be the strictest and was ranked highest by the locals as regards conservation (Guthiga and Mburu, *op cit*). The FD and Quakers Church Mission allow regulated extraction in the parts they manage.

3. Other (Additional) Relevant Tables

B) Moves towards adaptation according to Reid and Vogel

Increasing resilience and security →				
Objective	Coping with shocks	Risk Diversification		Adaptation
Single household	Intensive labour inputs Draw on savings Sale of assets Cut down on consumption Migration to marginal lands	Marriage and extended family Buffer stocks	Crop diversification Income diversification Investment in human and physical capital	Preventive health Successful migration More secure income source
Group based	Mutual support networks	Investment in social capital	Occupational associations Savings and credit associations	Collective action for infrastructure Common property resources
Market based	Sale of financial assets Loans from banks Old age annuities Accident insurance	Insurance	Savings accounts Microfinance	
Publicly provided	SOCIAL PROTECTION Social assistance Workforce Subsidies Social funds Cash transfers	Pension scheme Mandated insurances	Agriculture extension Liberalisation of trade Protection of property rights	Good macroeconomic policy Environmental, health, and labour policy

Source: *P. Reid & C. Vogel (2006)*

B) Selected Variables Used in vulnerability assessment and a sample of proposed variables for characterizing dynamic vulnerability (Ramachandran and Eastman, 1997)

Traditional Indicators of Vulnerability	**Indicators of Dynamic Vulnerability**
Share of drought resistant crops	Change in access or level of investment in transportation and other infrastructure (e.g. construction of new roads or new port facilities)
Agroclimatic zones	Change in availability of market facilities
Average NDVI for the last 3 seasons	Change in access to credit
Rainfall Index	Change in crop subsidy policies
Frequency of drought by watershed	Change in national trade or investment policy stance
Percentage crop area	Change in levels or shares of international trade or investment
Percentage Cash crop	Change in national or regional industrial structure
Variability of agricultural production	Change in soil fertility
Access to infrastructure	Change in climate variability
Per capita livestock units	Large scale internal movement of population (e.g. rural-urban migration)
Per capita staple food production	Change in rates of HIV/AIDS among rural households
Average cash income	Escalation of civil war or other military conflict
Population density	
Infant mortality index	
Percentage of female headed households	
Female literacy rate	
Average cost to travel to district market	
Average cost to travel to nearest urban market	
Civil insecurity	

NDVI – Normalized Differential Vegetation Index

C) Data Collection and Analysis

The field research was designed in two main stages.

Stage I

a. Literature review and discussions with local experts mainly drawn from the Kenyan Central Bureau of Statistics and University of Nairobi's Institute of Development Studies. These were people who had been involved in welfare monitoring surveys as well as district development reports. The discussions helped to select significant factors affecting vulnerability and adaptability among rural households from a broad list obtained during literature review. The discussions therefore helped arrive at a roughly ordered list of adaptive capacity factors. The experts were presented with alternative ways of measuring the ordered list of adaptive capacity factors for purposes of critic.

A comprehensive questionnaire was then designed to include a double-check mechanism, for instance, responses to questions on household income could be verified by responses to questions on household expenditure since one can only spend what one has obtained. This comprehensive questionnaire was necessary since most households in the area do not keep written records of their financial/economic affairs.

b. Pre-visit in Kakamega District of Kenya in September 2007 - January 2008. Given that the author had carried out previous research in the same area of study, the area was not entirely new to him. However, there was need to check whether all the relevant factors for vulnerability and adaptability had been included in the research design and whether the questionnaire would be effective in capturing the necessary data. During the pre-visit, four research assistants (all of whom had previously worked with other researchers in the area of study during the 10-year BIOTA East project) were selected and trained to administer the questionnaire in the local dialect and/or the national language (Swahili).

The research assistants were trained to translate research issues to local settings so as to obtain appropriate responses. During the testing of the questionnaire for instance, respondents were presented with 5 empty glasses and 3 liters of water then asked to name key sources of vulnerability (one for each glass) and pour certain amounts of water in the glasses corresponding to how pressing each source of vulnerability was. Motivations for adopting various strategies were also asked. After this process, superfluous questions were removed from the comprehensive questionnaire and response options adjusted. In seeking to access the household level of awareness of environmental stress issues and actions taken against the same, the pre-visit experience showed that a great majority of households only planted trees which could later be used as timber or firewood. The planting of trees for hedges, shadows or fruits featured insignificantly while the total number of trees was limited by the small household landholding. This informed the allocation of response options in the questionnaire.

The pre-visit experience, literature review and critic from the experts enabled the author to come up with weighted factors & their indicators as well as the most effective design for measuring adaptive capacity.

c. Development of a HACI model with in-built weighting via sub-variables and varied scaling of indicators. Informed by the pre-visit experience, expert views and literature review,

key factors were accorded detailed measurement in the form of multiple sub-variables and multiple response options. Factors with relatively low significance had fewer sub-variables. As an example, the HACI variable (sub-index) 'household economic wellbeing' has five sub-variables with a total of 21 response options thereby enabling it to contribute a maximum total of 19 points to the HACI (please see table 4a on page 75). On the other hand, the HACI variable (sub-index) 'housing quality' only has a maximum total of four points to contribute to the HACI thereby reflecting its relatively low weight.

Stage II

a. Multi-stage random sampling, data collection with help of local interviewers.

b. The four local research assistants administered the comprehensive questionnaire. Probing was done in the local dialect and where main respondents (mostly the household head) could not express him- or herself effectively, the most educated household member assisted. Each research assistant administered 2 – 3 questionnaires per day over the period March – September 2009.

c. There was daily data entry and verification by the author and the assistants. Where necessary, follow up interviews were carried out.

d. The author also carried out participant observations and focused discussions with selected households to complement data collected through questionnaires. This aspect proved crucial in checking the reliability of the data as the field research proceeded.

4. Questionnaire

Section 1: Basic information, dwelling and location

a) Household coordinates respondent and interview information

Question code	Question	Response	Codes
s1aq1	CBS cluster number		See below
s1aq2	Household number		
s1aq3	Questionnaire Number		
s1aq4	GPS coordinates (Latitude)		
s1aq5	GPS coordinates (Longitude)		
s1aq6	Location		1 Municipality
			2 Shinyalu
			3 Ileho
			4 Kabras
			5 Lurambi
			6 Navakholo
			7 Ikolomani
s1aq7	Name of the respondent		
s1aq8	Sex of the respondent		1 Female
			2 Male
s1aq9	Respondent's position in the household		1 Household head
			2 Spouse of household head
			3 Child
			4 Other relation
s1aq10	Interview date		

Codes for s1aq2

Bukhonyi	1186	Lutaso	1178	Mutoto A	1181	Shikondi	1185	Sichilayi	1771
Bukhulunya	1774	Mahiakalo	1773	Muyundi	1180	Shingodo	1187		
Ewamakhumbi	1192	Matere	1194	Ngaywa	1183	Shingoto	1191		
Industrial	1772	Mavusi A	1179	Savane	1190	Shipalo	1188		
Lukala	1776	Musakhwe	1177	Shianda	1182	Shirere	1775		
Lukwilo	1170	Mushifumbi	1193	Shikhambi	1769	Shitsiulio	1189		

b) Dwelling characteristics

Question code	Question	Response	Codes
s1bq1	What is the chief source of cooking power in this household?		1 Firewood 2 Charcoal 3 Kerosene 4 Other
s1bq2	What is the main source of domestic water for the household?		1 Spring/Stream/River 2 Public pipe / Piped water from somewhere else 3 Pipe in the house 4 Other
s1bq3	Quality of household head's house		1 Mud-walled & Grass Thatched 2 Iron sheet-/Mud-walled & iron sheet roofed 3 Semi-permanent: Iron sheets; Mud & Concrete and Cement 4 Permanent : Iron sheets/Tiles; Bricks/Concrete/Stone and Cement
s1bq4	Number of grass thatched huts belonging to the household		
s1bq5	Distance to nearest access road (not foot path) in metres		
s1bq6	Type of access road		1 Earth 2 Murram 3 Tarmac
s1bq7	Distance to nearest market (in km)		
s1bq8	Distance to the divisional headquarters (in km)		
s1bq9	Distance to the district headquarters (in km)		
To assess whether households near roads, markets, public offices have a higher adaptive capacity!			

Section 2: Basic individual characteristics (all individuals, including ALL children, house help – start with household head)

	s2q1	*s2q2*	*s2q3*	*s2q4*	*s2q5*	*s2q6*	*s2q7*	*s2q8*	*s2q9*
ID	Relationship to household head	Age	Sex	Marital status	Health status	Literacy status	Education & Training (highest level)	Years of education	Occupational status
	1 Household head 2 Spouse of household head 3 Child 4 Grandparent 5 Other relatives 6 Worker/House help 7 Other	0 if younger than 1	1 female 2 male	1 Single 2 Married (mono.) 3 Married (poly.) 4 Widowed (mono.) 5 Widowed (poly.) 6 Separated/divorced 7 Cohabiting	1 100% fit 2 Disabled 3 Sickly - asthma, epilepsy 4 Terminally ill 5 Other	1 Neither read nor write 2 Read only 3 Write only 4 Read and write	1 No formal schooling 2 Primary incomplete 3 Primary complete 4 Secondary incomplete 5 Secondary complete 6 Vocational training 7 Tertiary college (no university) 8 University 9 University +		1 Too young (up to 12)/ too old to work 2 Student 3 Unemployed 4 Occupied 5 Housework **If 4: Fill section 3 for this member now**
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									

s2q10	Household size (should be consistent with the above table, repeat this number to the respondent in order to make sure you did not forget anybody)	
s2q11	Weight of household size (Adult Equivalents; <6 = 0.25, <12 = 0.5, <18 = 0.75 & >18 = 1): (1) < 3, (2) 3 – 6, (3) 7-10 & (4) > 10	
s2q12	No of dependants and code: (Adult Equivalents; <6 = 0.25, <12 = 0.5, <18 = 0.75 & >18 = 1: (1) < 3, (2) 3 – 6, (3) 7-10 & (4) > 10	
s2q13	Number of members suffering from long term illness such as TB, Cancer, Diabetes *et cetera*	
s2q14	Age of household head (1) < 30 (2) 30 – 40 (3) 40 – 50 (4) > 50	
s2q15	Level of education of household head (same codes as s2q7 above)	
s2q16	Level of education of highest educated household member other than head (same codes as s2q7 above)	

Section 3: Job characteristics (DON'T FORGET TO PUT THE NUMBER OF THE INDIVIDUAL FROM SECTION 2 FIRST)

	s3q1	*s3q2*	*s3q3*	*s3q4*			*s3q5*	*s3q6*	*s3q7*	*s3q8*		
ID s2	Main occupation	Sector/Main crop on farm	How many days per week in this occupation?	How much do you earn in this occupation (in KES) (ONLY IF EMPLOYEE/WORKER)?			Secondary occupation	Sector/Main crop on farm	How many days per week in this occupation?	How much do you earn in this occupation (in KES) (ONLY IF EMPLOYEE/WORKER)?		
	1 Farmer 2 Employee/Worker 4 Non-agricultural self-employment / employer 4 Non-paid household member	See codes below		Only one entry per individual!			1 Farmer 2 Employee/Worker 3 Non-agricultural self-employment / employer 4 Non-remunerated household member	See codes below		Only one entry per individual!		
				Daily	Weekly	Monthly				Daily	Weekly	Monthly

Codes for s3q2 and s3q6

1	Food crops	9	Food production (including bakeries, butchers, etc.)	17	Transport (other)	25	Formal services (banking, insurance, real estate)
2	Tea	10	Furniture, wood-related carpentry, timber materials	18	Repair of motor vehicles	26	Church, NGOs, international organizations etc.
3	Sugar cane	11	Metal works	19	Other repair shops (bicycles etc)	27	Hotels and restaurants
4	Vegetables	12	Charcoal production	20	Retail - street vendor	28	Government and government agencies, public service
5	Other crops (trees etc.)	13	Other manufacturing (clothing, textiles etc.)	21	Retail - fixed stall, shop	29	House help
6	Livestock	14	Construction	22	Wholesale	30	Other informal services (Shoe shining, washing etc.)
7	Fishing and hunting	15	Transport (own motor vehicle)	23	Medical service, hospital, pharmacies	31	Other formal services (Security etc.)
8	Mining and quarrying	16	Transport (boda-boda)	24	Hair dressing and beauty	32	Other (Specify)

Section 4: Non-agricultural enterprise, i.e. self-employment (possibly with household members helping) or employer (if there is no non-agricultural enterprise go to section 5)

	s4q1	*s4q2*	*s4q3*	*s4q4*	*s4q5*			*s4q6*			*s4q7*
No.	Sector of the enterprise	When was this enterprise started?	How many household members participate in this enterprise?	How many hired workers work in this enterprise?	What is the amount of sales of your enterprise?			How much do you earn from this enterprise once you deduct all expenses e.g. for hired labour, for machines and raw materials?			The earning from this enterprise have increased/decreased/stayed constant during the last three years?
	See codes below	Year			Only one entry per row!			Only one entry per row!			1 Increased 2 Decreased 3 Stayed constant
					Daily	Weekly	Monthly	Daily	Weekly	Monthly	
1											
2											
3											
4											
5											
6											
7											
8											

Codes for s4q1

		9	Food production (including bakeries, butchers, etc.)	17	Transport (other)	25	Formal services (banking, insurance, real estate)
		10	Furniture, wood-related carpentry, timber materials	18	Repair of motor vehicles	26	Church, NGOs, international organizations etc.
		11	Metal works	19	Other repair shops (bicycles etc)	27	Hotels and restaurants
		12	Charcoal production	20	Retail - street vendor	28	Government and government agencies, public service
		13	Other manufacturing (clothing, textiles etc.)	21	Retail - fixed stall, shop	29	House help
		14	Construction	22	Wholesale	30	Other informal services (Shoe shining, washing etc.)
		15	Transport (own motor vehicle)	23	Medical service, hospital, pharmacies	31	Other formal services (Security etc.)
8	Mining and quarrying	16	Transport (boda-boda)	24	Hair dressing and beauty	32	Other (Specify)

Section 5: Land ownership and use (Go to section 7 if household does not have land)

Question code	Question	Response	Codes
s5q1	Do you own your land or is it rented?		1 Owned 2 Rented (Go to s5q4)
s5q2	Which type of land rights do you hold?		1 Title deed 2 Customary rights 3 Other
s5q3	Total land size of your owned land (in acres)		
s5q4	Do you have separate parcels of land, if yes, how many?		1 No (Go to s5q6) 2 One 3 Two 4 Three or more
s5q5	How far from here is the largest of these parcels? (in km)		
s5q6	When did you start farming independently? (year)		
s5q7	When you started farming how did you acquire your land?		1 Inherited 2 Bought 3 Rented 4 Government allocation 5 Other
s5q8	What was the size of your parents' farm? (in acres)		
s5q9	Since you started your farm, how has the size of the farm changed?		1 Increased 2 Decreased 3 Stayed constant (Go to s5q11)
s5q10	How have these changes occurred?		1 Sold out land 2 Bought land 3 Rented land 4 Divided land 5 Inherited land 6 Loss of land due to erosion 7 Other
s5q11	Total size of land under cultivation during the long rains 2007 (in acres)		
s5q12	Total size of land under cultivation during the short rains 2007 (in acres)		
s5q13	Do you leave some plots on your land fallow?		1 Yes 2 No (Go to s5q18)
s5q14	What is the size of the fallow plot in acres?		
s5q15	When was this fallow plot last under fallow?		1 More than 10 years ago 2 5-10 years ago 3 Less than 5 years ago 4 I do not remember (Go to s5q17)
s5q16	What was the duration of this former fallow? (in months)		
s5q17	In the past 10 years, have you changed fallow duration?		1. Increased | 2. Decreased | 3. Constant

Section 6: Agricultural production except livestock (go to section 7 if no agricultural activities)

a) Maize, beans, other staple food crops (4 main crops)

s6aq1	*s6aq2*	*s6aq3*		*s6aq4*		*s6aq5*		*s6aq6*	*s6aq7*	*s6aq8*
Crop code	Area in acres	Quantity harvested (last harvest after long rains)		Quantity sold of last harvest after long rains		Price per unit of quantity in KES at time of sale (not current price!)		Today you plant more/less/the same of this crop compared to three years ago?	Today are yields of this crop higher or lower compared to three years ago?	Which seeds do you use?
See below		Quantity codes see below		Quantity codes see below		Quantity codes see below		1 More 2 Less 3 The same	1 Higher 2 Lower 3 The same	1 Local 2 Improved 3 Mixed 4 Other
		Unit of quantity	Quantity	Unit of quantity	Quantity	Unit of quantity	Price			

Codes for s6aq1

1	Maize	9	Groundnuts
2	Beans	10	Irish potatoes
3	Sweet potatoes	11	Soy beans
4	Cooking Banana		
5	Cassava		
6	Sorghum		
7	Arrow roots		
8	Millet		

Unit of quantity codes

1	Piece/Number
2	Kg
3	90 kg bag
4	Gorogoro
5	Bunch

b) Tea (if no tea go to section s6c)

s6bq1	*s6bq2*	*s6bq3*		*s6bq4*
Crop	Area in acres	Monthly harvest		Today you plant more/less/the same of this crop compared to three years ago?
		Quantity codes see above		1 More 2 Less 3 The same
		Unit of quantity	Quantity	
Tea				

c) Sugar cane (if no sugar cane go to s6d)

s6cq1	*s6cq2*	*s6cq3*			*s6dq3*		*s6cq6*		*s6cq7*
Crop	Area in acres	Date of last harvest		How long had the sugar cane been on the field before it was harvested (in months)?	Quantity harvested (last harvest)		Price per unit of quantity in KES at time of sale (not current price!)		Today you plant more/less/the same of this crop compared to three years ago?
					1 Tons 2 Big tractor 3 Small tractor		1 Tons 2 Big tractor 3 Small tractor		1 More 2 Less 3 Same
		month	year		Unit of quantity	Quantity	Unit of quantity	Price	
Sugar cane									

d) Other crops and vegetables max. 3, ranked by importance (if no other crops etc. go to section s6e)

s6dq1	*s6dq2*	*s6dq3*	*s6dq4*		*s6dq5*		*S5dq6*		*s6dq7*
Code	Area in acres	How many harvests per year?	Quantity harvested (last harvest)		Quantity sold of last harvest		Price per unit of quantity in KES at time of sale (not current price!)		Today you plant more/less/the same of this crop compared to three years ago?
See below			Quantity codes see below		Quantity codes see below		Quantity codes see above		1 More 2 Less 3 Same
			Unit of quantity	Quantity	Unit of quantity	Quantity	Unit of quantity	Price	

Codes for s6dq1

1	Napier	7	Mrere/mrenda/Corchorus Olitoris/Lihoo	13	Terere	19	Egg Plant/Aubergine
2	Local sugarcane	8	Tsisagaa/Spider Weed/Gynandropsis Gynandra	14	Nderema/Basela Alba	Unit of quantity codes	
3	Kunde	9	Malenge/Tseveve/Pumpkin Leaves/Sebebe	15	Onions	1	Piece/Number
4	Sukuma	10	Dodo/Toto/Amaranthus Hybridus/Mchicha/Terere/Libokoi	16	Chili/Pili-Pili	2	Kg
5	Cabbage	11	Lisutsa/Sucha	17	Kanzera	3	90 kg bag
6	Miro/mito/Crotolaria	12	Tomato	18	Black night shade/ Isutsa	4	Gorogoro
						5	Bunch

e) Fruit crops, max. 3, ranked by importance (if no fruit crops etc. go to section 7)

s6eq1	*s6eq2*	*s6eq3*		*s6eq4*		*s6eq5*		*S6eq6*		*s6eq7*
Code	How many trees	How many harvests per year?		Quantity harvested (last harvest)		Quantity sold of last harvest		Price per unit of quantity in KES at time of sale (not current price!)		Today you had more/less/the same of this tree compared to three years ago?
See below				Quantity codes see below		Quantity codes see below		Quantity codes see above		1 More 2 Less 3 Same
				Unit of quantity	Quantity	Unit of quantity	Quantity	Unit of quantity	Price	

Codes for units of quantity

1	Piece/Number
2	Kg
3	90 kg bag
4	Gorogoro
5	Bunch

Codes for s6eq1

1	Ripening bananas	7	Loquarts
2	Sweet bananas	8	Musioma/Zambarau
3	Avocado	9	Passion Fruit
4	Mango	10	White support
5	Guava	11	Mukhombero
6	Paw Paw	12	Mufudu

Section 7: Other income sources (and migration)

Question code	**Question**	**Response**	**Codes**
S7q1	Renting out land or property per month (in KES)		
S7q2	Pension payments per month (in KES)		
S7q3	Other income (interest earnings, dividends etc. per month , other public transfers e.g. unemployment benefits) per month (in KES)		
S7q4	How many former household members have migrated during the last 10 years?		
S7q5	What is the amount the household receives from family members living outside this household (in KES)?		Per week Per month Per year Only one entry!
S7q6	Today you rely more or less on remittances than three years ago?		1 More 2 Less 3 Same

Section 8: Assets and Livestock

	S8q1	*S8q2*	*S8q3*	*S8q4*
	Type of asset	Quantity	Value as of today (livestock based on CEU)	Today you own more/less/same of this asset compared to three years ago?
				1 More 2 Less 3 Same
1	Cows			
2	Pigs			
3	Chicken/other poultry			
4	Goats or sheep			
5	Radio			
6	Television			
7	Bicycle			
8	Mobile phone			
9	Fixed telephone			
10	Rental houses	**Put total value!**		
11	Sewing machine			
12	Kerosene stove			
13	Energy saving jiko	**Put total value!**		
14	Sofa set	**Put total value!**		
15	Posho mills			
16	Generators			
17	Ox plough			
18	Other			

Cattle Equivalent Units (CEU) are based on mean price ratios between different livestock types (for instance, ox = 1, pig = 0.28, goat = 0.14, sheep = 0.10, turkey = 0.04, chicken = 0.02, others = actual price/mean ox price).

Section 9: Agriculture/Farming vis a vis other sources of income

Question code	Question	Response	Codes
S9q1	Contribution of Farming to Household Wellbeing		1 Main base of Livelihood 2 Equally important base alongside other(s) 3 Not a significant base for livelihood
	Note the code of the household head's level of education here (keen on has secondary school & below)		
S9q2	How many significant (at least 20% of total income) sources of income does the household have?		1 One 2 Two 3 Three 4 More than Three ( ) Record code of Educ. Level 2 No

Section 10: Household expenditure

a) Items with high share of home or free consumption

	S10aq1	*S10aq2*			*S10aq3*			*S10aq4*	
		Home produced (last month)			Purchased (last month)			Free – Presents, gifts (last month)	
		Quantity codes below			Quantity codes below			Quantity codes below	
		Unit of quantity	Quantity	Price per Unit of Quantity	Unit of Quantity	Quantity	Price per Unit of Quantity	Unit of Quantity	Quantity
1	Maize								
2	Beans								
3	Cooking Bananas								
4	Sweet potatoes								
5	Cassava								
6	Arrow roots								
7	Fire Wood								

Codes for units of quantity

1	Piece/Number
2	Kg
3	90 kg bag
4	Gorogoro
5	Bunch

b) Other food items

	S10bq1	*S10bq2*	*S10bq3*
		Value of home production (last month)	Value of purchases (last month)
8	Other staple foods or derived products (rice, sorghum, millet, all types of flour)		
9	Vegetables e.g. tomatoes, traditional, cabbages etc.		
10	Fruits e.g. sweet bananas, paw-paw, mango, etc		
11	Eggs		
12	Dairy products e.g. milk, yoghurt		
13	Oil and fats		
14	Meat e.g. beef, fish, pork etc.		
15	Tobacco products e.g. cigarettes etc		
16	Alcoholic drinks e.g. traditional brew etc.		
17	Tinned food e.g. fish, baby food		
18	Spices e.g. salt, chilly, baking powder etc.		
19	Beverages e.g. soda, coffee, tea, soy, chocolate etc.		
20	Sugar e.g. nguru, etc		
21	Jam, honey, sweets etc.		
22	Expenditure in food kiosks /restaurants		

c) Regular non-food items

	S10cq1	*S10cq2*	*S10cq3*
		Value of home production (last month)	Value of purchases (last month)
23	Clothing including blankets, pillows, mosquito nets, etc (all)		
24	Footwear (all)		
25	Household utensils		
26	Furniture		
27	Personal goods e.g. jewellery; wallets, etc.		
28	Household operation e.g. soap, match box, detergents, candles etc.		
29	Personal care e.g. salon, sanitary pads, hair oil		
30	Charcoal		
31	Kerosene /paraffin		
32	Electricity		
33	Communication costs e.g. phone/stamps		
34	Individual transport costs e.g. boda-boda, buses, taxis etc		
35	Farm products transport costs		
36	Electricity, water etc. (bills).		
37	Rent of rented house		
38	Rent of rented farm		
39	Recreation and entertainment e.g. news paper, video show , magazines		
40	Domestic worker /s		
41	Maintenance of housing unit e.g. repairs		
42	School/college/university fees and items		
43	Health and Sanitation		
44	Taxes and Market fees		
45	Contributions to the church / mosques		
46	Contributions to other organizations		
47	Interest paid on loans		
48	Savings		

Section 11: The role of the forest

Question code	Question	Response	Codes
s11q1	Do you think the Kakamega forest is important?		1 Yes 2 No
s11q2	How often do household members go into the forest?		1 Never (Go to section 12) 2 Once a year 3 Once every month 4 Once a week 5 Several times a week
s11q3	Why, major reason?		1 Collect firewood 2 Touring or Leisure 3 Collect medicinal herbs 4 Cattle grazing 5 Land cultivation 6 Employment 7 Water collection 8 Wild honey 9 Charcoal burning 10 Timber, plywood, seedlings 11 Education 12 Other
s11q4	Why, other reason?		1 Collect firewood 2 Touring or Leisure 3 Collect medicinal herbs 4 Cattle grazing 5 Land cultivation 6 Employment 7 Water collection 8 Wild honey 9 Charcoal burning 10 Timber, plywood, seedlings 11 Education 13 Collect thatch 12 Other
s11q5	Do you have rights to use the forest resources		1 Yes 2 No S11q6 Note relevant code for main and other reasons as given in s11q3 & 4 above
S11q7	What additional benefits does the household have due to its access to the forest?		1 2 3 4 5

s11q8	Apart from the forest, to which other common property do you have rights?	1	None	
		2	Grazing land	
		3	Other	

Section 12: Migration, Remittances, Social Capital and Networking (rural – rural migration ONLY out of district)
a) Individual information of the migrants; Remittances

	S12aq1	*S12aq2*	*S12aq3*	*S12aq4*	*S12aq5*	*S12aq6*	*S12aq7*		*S12aq8*	*S12aq9*
ID emigrated HH-hold members	Sex	Age	Relationship to HH-Head	Marital Status	Education level	Kind of migration	Last time the migrant was away, how long did he stay?		Year and month of migration (first time of migration if periodic/irregular)	Regularity of coming home
NAME!	1 Fem. 2 Male		1 Household head 2 Spouse to hhh 3 Child 4 Grandparent 5 Other relative 6 Other	1 Married 2 Divorced 3 Separated 4 Widowed 5 Single	1 No formal schooling 2 Primary incomplete 3 Primary complete 4 Secondary incomplete 5 Secondary complete 6 Vocational training 7 Tertiary college 8 University +	1 Periodic/ Seasonal 2 Irregular 3 Long-term If 3 go to s12aq8	Months	Weeks		1 Weekly 2 Once a month 3 Several times a year 4 Once a year 5 Less than once a year
1										
2										
3										
4										
5										

	S12aq10		*S12aq11*	*S12aq12*	*S12aq13*		*S12aq14*	*S12aq15*
Member ID	Types of remittances being sent to household		Regularity of receiving remittances	Approx. amount each time (in KES)	Types of remittances send to migrants		Regularity	Approx. amount each time (in KES)
	1 Cash 2 Foodstuff 3 Agricultural inputs 4 Education fees 5 Other		1 Once a week 2 Once a month 3 Several times per year 4 Once a year	Including the value of non-cash items!	1 Cash 2 Foodstuff 3 Agricultural inputs 4 Education fees 5 Transport costs 6 Other		1 Once a week 2 Once a month 3 Several times per year 4 Once a year	Including the value of non-cash items!
	Main type	Second type	5 Once in a while		Main type	Second type	5 Once in a while	
1								
2								
3								

S12aq16	How does the household receive or send money from or to the migrated person (most important)?		1 By the migrant 2 By a relative 3 By a friend 4 By a workmate of migrant	5 Bank transfer 6 Post office 7 Bus companies, matatus, taxis 8 Other

Section 12b: Social Capital and Networking

Question code	Question	Response	Codes
s12bq1	Is anybody of this household a member of a credit scheme or group?		1 Yes 2 No
s12bq2	Does the household have an outstanding loan or have you borrowed money during the last 12 months?		1 Yes 2 No (Go to s12bq4)
s12bq3	This loan is given by		1 Neighbours or friends 2 Savings group 3 Other microfinance institutions 4 Cooperatives 5 Banks 6 Other
s12bq4	Is anybody of this household a member of a farmers' organisation?		1 Yes 2 No Benefit:
s12bq5	Is anybody of this household a member of a trade union?		1 Yes 2 No Benefit:
s12bq6	Is anybody of this household a member of a self-help group?		1 Yes 2 No Benefit:
S12bq7	Is anybody from this household a member of a burial society?		1 Yes 2 No Benefit:
S12bq8	Is anybody from this household a member of any other kind of group not included here? Please describe briefly.		1 Yes 2 No Benefit:

Question code	Question	Response	Codes
s12bq9	Does membership to any of the organisations/groups to which members belong entail regular fee payments?		1 Yes 2 No
s12bq10	Does the household have somebody located at the district/provincial headquarters or at least 50 km away on which it can rely to bail it out on short notice in case of an emergency?		1 Yes 2 No
s12bq11	What is the composition of the household's social network?		1 Family& friends outside the household 2 1 and Traditional leadership within the village 3 1, 2 and lower formal government: Assistant chief, chief, councillor 4 3 and higher levels (MP, DO, NGO officers, Agric. Extension Officers)
s12bq12	Number of local groups to which at least one household member belongs (cross check with s12bq1-6)		1 Membership to <2 groups 2 Membership in to 2 - 4 groups 3 Membership to 5 - 7 groups 4 Membership to > 7 groups
s12bq13	Richness of contacts and/or groups with which a household has links (use 2 water jars to measure).		1 Contacts are resource poorer than the household 2 Low resource access 3 Medium-level access 4 High access level
s12bq14	In a worst case scenario, can the household rely on friends and relatives to survive for temporary period as long as the tough period persists?		1 Yes 2 No
S12bq15	If "Yes" in s12bq12 above, for how many days at the maximum?		1 1 week 2 2 Weeks 3 1 Month 4 > 1 Month 5 Do not know
S12bq16	Have you had a major misunderstanding (e.g. over land, cattle etc) with anyone over the last 5 years?		1 Yes 2 No
S12bq17	If 'Yes' in s12q13 above, was the dispute resolved?		1 Yes 2 No
S12bq18	If 'Yes' in s12q14 above, who guided the resolution and how long did it take to resolve?		1 Clansmen 2 Village elders 3 Assistant Chief/Chief 4 Court ( ) Days

Section 13: Shocks and Natural as well as Institutional Environment

	S13q1	*S13q2*	*S13q3*
	Shocks: Has the household been negatively affected by the following events within the past 5 years?	Rank the 3 most important shocks	When did shock(s) occur (Year)? (Frequency)
	1 Yes 2 No (Frequency)	1 Most severe 2 Second most severe 3 Third most severe	Only for the three most important shocks!
1	Drought related crop failure		
2	Weather related loss of livestock		
3	Floods		
4	Wind/Hailstone destruction		
5	Epidemics related to weather/climate change		
6	Crop diseases or pests		
7	Livestock died or stolen		
8	Business failure or loss of job		
9	End of regular assistance (aid, remittances) from outside the household		
10	Large fall in prices for crops		
11	Large rise in food prices		
12	Large rise in agricultural input prices		
13	Chronic or severe illness of working household member		
14	Chronic or severe illness of household member (who does not work, too old or too young)		
15	Death of working household member		
16	Birth in the household		
17	Household member victim of crime (robbery, carjacking, assault)		
18	Clan clashes		
19	Restricted access to forest resources		
20	Heightened difficulty in finding: Herbs, firewood, thatch		

S13q4	What did the household do to pull out of the past (weather-event-related) shocks?	1	Reduced consumption/expenditure
		2	Assisted by relatives and friends
		3	Borrowed from contacts/institutions
		4	Sold some assets
		5	Other

Environmental stress and climate change

	S13q5		*S13q6*	*S13q7*
	Can the respondent describe any signs of environmental stress based on the experience of the past 5 years?		Rank the 3 most visible/important signs	Since when was the sign observed (Year)?
		1 Yes 2 No	1 Most severe 2 Second most severe 3 Third most severe	Only for the three most important shocks!
1	Drier weather			
2	Soil erosion			
3	Soil degradation (barrenness/erosion/leaching)			
4	Floods			
5	Deforestation (Gauge ease of finding wood/timber)			

s13q8	What do you think of such signs as in s13q5 above?		1	Normal occurrence occasioning no cause for alarm
			2	Warning signs telling us to do things differently
S13q9	Has your thinking about the signs in s13q5 above changed over the past 5 years?		1	Yes
			2	No
S13q10	Is the household currently more/less threatened by environmental stress than 5 years ago?		1	Yes
			2	No
S13q11	If "Yes" in s13q11 what exactly makes you think so?		1	Increased frequency of negative shocks in the recent times
			2	Less than full recovery from the previous shock
			3	Worsening environmental situation
			4	Other (describe briefly)
S13q12	Have you heard about climate change?		1	Yes
			2	No
S13q13	If "Yes" in s13q12 above, do you feel affected by climate change?		1	Yes
			2	No
S13q13b	How has climate change affected you?			
S13q14	Do you see any link between the local environmental problems and climate change? (Briefly describe)		1	Yes
			2	No

S13q15	How has the household prepared for the threats posed by environmental changes? Maximum 3 in order of reducing significance)		1	Establishing ridges, furrows, gabions and other soil erosion control features
			2	Using compost/farm yard manure
			3	Using artificial fertilizers and other better land management methods
			4	Planting trees
			5	Acquiring adaptation information
			6	Joining forces with others to counteract
			7	Zero grazing and other better livestock husbandry methods
			8	Other (briefly describe)
S13q16	Other than firewood, what other sources of cooking energy does the household use		1	Charcoal
			2	Kerosene (in stoves)
			3	Gas
			4	Electricity
			5	Other (saw dust etc)

S13q17	If the household responded by planting trees (relate to s13q15 above): What is the number of on-farm planted trees?		1	None
			2	Less than 5
			3	5 - 10
			4	More than 10
S13q18	What are the conditions that encouraged or hindered your taking the actions (in s13q15 above) against environmental/climatic stress?		1	Availability of household land
			2	Ease of finding seedlings
			3	Access to information
			4	Presence of active organisations
			5	Interaction with other residents
			6	Other
S13q19	Has there been any impact so far of the actions (in s13q15 above) taken?		1	No Impact yet
			2	Some impact
S13q20	How effective are the actions (in s13q15 above) taken in mitigating risk? (Use water jars to measure).		1	Ineffective
			2	Almost ineffective
			3	Average
			4	Almost full mitigation
			5	Full Mitigation
S13q21	Has the household had to abandon any of the initially taken actions (in s13q15 above)?		1	Yes
			2	No
S13q22	If 'Yes' in s13q21 above, for what reason		1	Negative side effects
			2	Land scarcity
			3	Discontinued support from govt/organisation
			4	Ineffective
			5	Other (Briefly describe)
S13q23	Are there neighbours or relatives who have taken some action(s) to mitigate environmental and climatic challenges?		1	Yes
			2	No
S13q24	If 'Yes' in s13q23 above, how have the actions of neighbours & relatives influenced you?		1	
			2	
			3	
			4	
			5	
S13q25	What factors motivated you to take the mitigation actions (in s13q15) you took?		1	Demonstration effect from neighbours/acquaintances
			2	Availability of trees seedlings
			3	Encouragement from govt/NGO
			4	Own initiative as the environmental changes occurred
S13q26	What key decisions did the household have to make in the process of reacting to the environmental changes (in s13q5) changes?		1	
			2	
			3	
			4	

S13q27	How were the decisions made for the actions taken in reaction to environmental challenges (in s13q15)?		1	Each household member did his/her own actions
			2	Unilaterally by the household head
			3	Household head in consultation with household members
S13q28	What has been the reaction of household members to the decisions and actions taken?		1	Significant disgruntlement
			2	Reducing disgruntlement
			3	Partial support
			4	Full support
S13q29	Apart from the problems posed by environmental stress and climate related factors, what other additional factors made the household to take the actions already taken (s13q15) in response to environmental stress?		1	Incentives from organisation
			2	Promise of additional income
			3	Government surveillance
			4	Other (Briefly describe)
S13q30	What in your opinion is (are) the best thing(s) for the household to do to meet the environmental-stress-related challenges? Rank in order of decreasing importance.		1	
			2	
			3	
			4	
S13q31	If the household is not doing the best thing (answer to S13q30) what is the major impediment?		1	Lack of money
			2	Lack of technological know-how
			3	Other (Briefly describe)
S13q32	How have the government officers aided/impeded the household's efforts to mitigate the challenges arising due to environmental stress?		1	Awareness creation
			2	Too far to be reached
			3	Unclear policy direction
			4	Too much restriction
			5	Other (Briefly describe)
S13q33	Which organisations – if any – (public/private) promote activities to mitigate environmental/climatic challenges in the area?		1	
			2	
			3	
			4	
S13q34	What key activity is carried out by the organisations (in s13q33 above)? Please match codes for this question with those in s13q33.		1	
			2	
			3	
			4	
S13q35	What can the government and/or private organisations do better in order to help mitigate the challenges posed by environmental stress?		1	Provide more awareness creation
			2	Provide more extension services
			3	Provide alternative sources of energy
			4	Other (Specify)
S13q36	Under what conditions would you consider planting more trees on your farm?		1	If there is more land
			2	If seedlings are available
			3	If I can prevent my trees from being destroyed
			4	Other (Specify)

Section 14: Input use, extension, fencing and pollination
a) Non-labour input use

S14aq1		*S14aq2*
Non-labour inputs: Do you use the following inputs?		Today you use more/less/the same of this input compared to three years ago
	1 Yes 2 No	1 More 2 Less 3 The same
Improved seed		
Manure		
Inorganic fertilizer		
Pesticides and/or herbicides		
Acaricides		
Insemination with better breeds		
Improved feeds		

S14aq3		*S14aq4*
Non-labour inputs: Do you use the following inputs every time you plant?		Today you use these inputs as recommended for your size of farm and type of crops/livestock
	1 Yes 2 No	1 All the times 2 75% of the times 3 50% of the times 4 Occasionally (<50% of the time) 5 Never
Improved seed		
Manure		
Inorganic fertilizer		
Pesticides and/or herbicides		
Acaricides		
Insemination with better breeds		
Improved feeds		

b) Labour input, extension, and technology

Question code	Question	Response	Codes
S14bq1	How many household members (without payment) work on the farm?		
S14bq2	How many hired workers work permanently on your farm who are not members of the household?		
S14bq3	In very busy times (harvesting or weeding), how many hired workers work on your farm (including permanent workers)?		
S14bq4	Today you hire more/less/same number of workers compared to three years ago?		1 More 2 Less 3 Same
S14bq5	What is the main source of agricultural information?		1 Agricultural extension 2 Community based organizations 3 NGOs 4 Church 5 Farmer groups/farmer associations 6 Other 7 None
S14bq6	How often are you visited by an agricultural extension officer?		0 Not at all 1 1 or 2 times in the past 5 years 2 Once every year 3 Once every month 4 Weekly
S14bq7	Have you hired a tractor in the past 12 months?		1 Yes 2 No
S14bq8	Have you hired oxen power in the past 12 months?		1 Yes 2 No

Note: This questionnaire was developed with contribution and support from other researchers (such as Jahn Lay and George M. Michuki) under the BIOTA E14c research group. This version was tailor-made to fit the research needs of the author.

Declaration

I, Mwamba Leonard Otieno, declare that this is my own piece of work, that sections from the works of others have been appropriately quoted and acknowledged and that it has never been presented for examination at any other time at any other university.

Leonard Otieno Mwamba (Author) Leipzig, 12th March, 2013.

This PhD Dissertation has been submitted with the approval of university supervisors:

Professor Dr. Robert Kappel (1st Supervisor)

Professor Dr. Hans-Heinrich Bass (2nd Supervisor)

Eidesstattliche Erklärung

Ich erkläre hiermit, dass ich zur Anfertigung der vorliegenden Arbeit keine anderen als die angegebenen Quellen und Hilfsmittel und keine nicht genannte fremde Hilfe in Anspruch genommen habe.

Mir ist bekannt, dass eine unwahrheitsgemäße Erklärung als Täuschung im Sinne der Prüfungsordnung gilt.

Leonard Otieno Mwamba (Autor) Ort, Datum: Leipzig, 12. März 2013

Diese Dissertation wurde an der Uni-Leipzig vorgelegt mit der Zustimmung der Gutachter:

Professor Dr. Robert Kappel (Erstegutachter)

Professor Dr. Hans-Heinrich Bass (Zweitgutachter)